SILICON CHIP

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Our all-new, very clever remote-controlled table lamp dimmer

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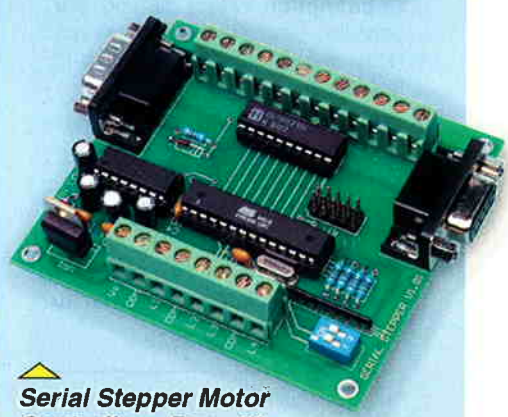

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Publisher's Letter

Low-cost digital cameras no match for 35mm equivalents

Have you been considering a change to a digital camera? You've seen all the hype, everybody's doing it and perhaps you are getting the strong message that your old faithful 35mm camera is just "old hat" and nobody who is anybody would be seen dead with that old clunker!" That is how it was with me and my techno-savvy daughters who thought it was time I "got with it". Of course, at SILICON CHIP we have been using a high-end Nikon digital camera for some time now, so I do know the capabilities of digital cameras, or so I thought.

And since I was about to depart on a world trip, I was seriously thinking about getting a compact digital camera to substitute for my old favourite SLR camera which is rather heavy and not one you can "point and shoot".

So I did a quick survey and it quickly came down to a choice between a Fuji Finepix S3500 and an Olympus C725. I wanted something I would be reasonably happy with and that my wife could operate easily without a long and tedious study of an instruction book.

Both cameras look like miniature 35mm SLR cameras but they're not. They are both reasonably compact and do not have buttons and controls which are so small that a mature (!) male has difficulty using them. And they both have good optical zoom ranges which is important when you're taking photos as a tourist. In the metal, the Fuji proved to be a lot bulkier than the Olympus although it is probably the better unit. So since I was travelling, I chose the Olympus. Unfortunately, you cannot try them in the store and that is a trap. And I had to buy bigger memory cards because the supplied 16MB is only good for about 20 shots.

So I got it home and put it all together, spent an hour with the instructions and turned it on to take some shots.

First problem is the LCD screen and viewfinder. The LCD screen is fine but try to use it outdoors for picture composition and it becomes very difficult, especially in bright sun when you need to use sunglasses. Alternatively, you try to use the LCD viewfinder but its pixels are so coarse that it is really not possible to tell whether the image is sharply in focus or not. In practice, the viewfinder needs to be optical (most are) rather than LCD.

In fact, focus is a problem, because in the normal automatic mode, it has aperture priority which means that the aperture is normally wide open at f2.8 (with shutter speed setting the exposure). That means that depth of field is always poor. Minimum aperture is f7, by the way. And then I found that I could not focus manually! Other than that, digital cameras require so much paraphernalia that you need to carry when on an overseas trip: extra memory cards, battery charger, USB cable, memory card reader, extra batteries, etc.

Ultimately, I decided that the almost $500 I had spent was not a good photographic package and certainly nothing like equivalent to a 35mm SLR camera purchased for the same money.

So what to do? I took the Olympus back and instead purchased a small automatic 35mm camera with a good zoom and automatic focus, for just over $100. It's a simple "point and shoot" camera. And for under $25, I purchased enough film for 200 photos. My wife loves it.

I will buy a digital camera, eventually. But not yet. By the way, it now looks as though a much better choice, for not much more money, would have been a Fuji E550. So there you go.

Leo Simpson

Innovative • Unique • Interesting • Hard to find products

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Attach this unit to any existing KVM and access all your machines remotely with a web browser to a BIOS level.
Cat 11674-7 $1099

What's New?

Digital & Analogue TV Tuner
A unique TV tuner card that can receive the older Analogue transmissions and newer DVB-T digital TV transmissions. The card also has an RCA input and the PC can be switched on and off with the included remote control.
Cat 3567-7 $199

DVI KVM Switch
Control two DVI PCs with the one DVI LCD monitor, keyboard and mouse.
Cat 11663-7 $169

SMS I/O Controller
Switch any electrical device on or off using SMS from any mobile phone.
Cat 17087-7 $1029

Bluetooth Barcode Scanner
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MAILBAG

No power switch for the TwinTen amplifier

I have read the article in the February 2005 issue on the TwinTen amplifier. One thing struck me as a bit strange, especially with your fixation about turning things off when not in use – it doesn't have a power switch.

To turn it off you either have to pull the power connector out of the back panel or turn it off at the wall GPO. With the intended use of this project as a kids' auxiliary amplifier, it will run all the time unless one method or the other is used to shut it off and if other kids' bedrooms are like my kids, the wall socket is "buried".

Sure, a power switch in the low-voltage AC circuit will not turn off the power pack but at least it will cut current draw to that which is the idle current of the plugpack.

I also am slightly bemused by the comment that this amplifier performed well on your staff member's "huge" stereo. I would not expect otherwise if this person's speakers were reasonably efficient – say in the order of 98dB/1W/1m). Any small amplifier will do well on speakers of this type. In the "olden days", pro speaker systems had efficiencies of 105dB/1W/1m) and they filled a whole auditorium full of people with just 50W.

However, when amplifiers are connected to today's rather abysmally inefficient speakers, an amplifier with this output runs out of "puff" really quickly.

Please don't get me wrong. The intended purpose of this amplifier is fully understood and I'm not knocking it; I just wanted to point out a couple of things. As an auxiliary amplifier, your new design is just what the doctor ordered . . . however, you can't turn it off!

Brad Sheargold,
via email.

Comment: as indicated in the article, the TwinTen was presented as a project for high school and college students. Many such schools will not let their students build anything with mains wiring in it, so using a plugpack is the only practical approach.

Certainly, running the plugpack continuously is a waste of electricity. And it does go against our philosophy of turning everything off because as you point out, laziness will mean that many such units will always be plugged in and never turned off.

If people want to, it would be reasonably straightforward to install a miniature toggle switch near the AC input socket but as you point out, that still leaves the plugpack powered up.

The TwinTen was tried with reasonably efficient loudspeaker (90dB/1W/1m) in a very large listening room.

PICAXE could be the death of logic

I have recently noticed the number of projects containing PICAXE components unnecessarily. In days past, these would have used a logic circuit. To prove my point, I built the recently featured circuit for connecting two phones but used logic instead. It worked a treat.

The same treatment can also be applied to other PICAXE circuits. Save the PICAXE for complicated circuits and use logic for the simple circuits. Otherwise in time, logic will be forgotten and everything will have to have programs before it will work, whereas with logic no program is required.

G. Moore,
Warialda, NSW.

Comment: we have produced quite a few projects with the PICAXE because it is easy to program and enables beginners to produce quite complicated circuit functions with very few components. Certainly, logic circuits can still produce good results but in most cases, the PICAXE can do it more cheaply.

Saving a Beta VCR from the tip

I have a Sanyo Betacord video recorder which I am loath to just put out for recycling where it will no doubt be trashed. If any of your readers are interested in it, it is a model VTC 9300PN. I can be contacted at **datgrays@smartchat.net.au**

Dave Williams,
via email.

White LEDs a good substitute in small torches

Now that ultra-bright white LEDs are readily available and very cheap, this must be placing some pressure on the manufacturers of small torch globes.

For instance, I have found it very simple to replace the tiny globes in Mini Maglites and also a small Coleman lamp (headband type) with a white LED.

The existing globes have a very limited life since in order to produce bright, relatively white light, they are run at more than their maximum rated voltage. From memory, with an ordinary globe, a 10% increase over rated voltage will more than halve their life.

Having had these fail on a regular basis and then finding the replacement globes to be overpriced, I have found white LEDs to be a perfect solution. They provide a pure white light, ideal for working on intricate equipment in confined dark areas, and they maintain their colour temperature over a large part of the battery life which is also extended, not to mention the long life of the LED itself.

With the Coleman lamp, the replacement was simply a matter of shortening the leads on the LED to the same length as the globe and then inserting it in the socket. You have to get the polarity right but if it is wrong, it simply doesn't light up; you then just rotate 180°!

The Maglites were a little more difficult. You need to open the hole in the lens to the diameter of the LED and also carefully bend the wires at the base of the LED so that they are closer together (approximately 1mm). This needs to be as close to the base of the

LED as possible. You then shorten the LED to the length of original lamp.

John Parncutt,
Glen Iris, Vic.

Comment: white LEDs can be dropped into any torch that uses only two 1.5V cells. Higher cell numbers will mean that a series limiting resistor will be required, otherwise the LED will be blown.

Digital set top boxes prone to impulse noise

As the day draws closer when the analog TV transmissions are switched off in Sydney and we are all forced to go digital, I think it may be timely to possibly report on how to best receive the digital broadcasts. I reside in a relatively poor reception area (for TV, radio, mobile, wireless broadband) in St. Clair, Western Sydney. I have gone to great lengths to fine tune my digital reception, without too much success. My analog reception was acceptable for Sydney VHF transmitters and basically as good as you'll get when tuning into the much stronger Wollongong UHF signals.

I bought a set-top box after reading positive reviews about it and, on the whole, am impressed. But within a one-minute period, the jitter and loss of sound and picture for up to 20 seconds at a time becomes quite irritable. The loud, high-pitched sounds that accompany the interference does not do my amplifier or expensive speaker system much good either. Most is caused by impulse interference from switching on anything in my house (lights, washing machine, model railway layout) and certain cars driving past.

I have a high-gain UHF and high gain VHF antenna. These are mounted on the opposite side of the house to the street, each fed to a combiner, with the output fed to a masthead amplified splitter feeding three different outlets. I improved the problem by installing quad-shield interconnects but the interference was still unacceptable. I then re-cabled the entire 3-year old installation with quad-shield cable, again with limited improvements.

There was no improvement after re-aiming my UHF antenna to Sydney to gauge the SBS reception. Similarly, there was no improvement after carefully aligning the respective antennas for the maximum gain (using the signal meter in the STB). I have now re-aimed my UHF antenna back to Wollongong and cannot view any Sydney transmissions without going mad after a few minutes! I also use the antenna to receive FM radio, because I have no other choice.

Considering that I have had training in electronics and telecommunications and employment for 10 years, imagine how the untrained member of the general public will get along! Speaking to my neighbours, nobody even knows what digital transmission is, or that their current TV receiver will be redundant in the next three years.

So how about a serious look at how to improve (eliminate!) the impulse noise problems inherently associated with digital TV transmission?

Robert Parnell,
via email.

Comment: large numbers of people out there in viewer-land are having similar problems but apart from the approach you have taken, we don't think there are any easy solutions. Given that situation, we really don't see how the Government will have the nerve to turn off analog transmissions in a few years time.

Solving an unbalanced transformer problem

B. K's letter on page 107 of the May 2005 issue about a non-centre-tapped transformer giving 31V and 33V output is interesting. His problem can probably be fixed by adding a couple of turns of hookup wire to the transformer and using the additional turns to add to (or subtract from) one of the windings.

Usually the volts per turn is about 1-1.5V and a few additional turns can be added through a toroid, if done carefully.

Rod Cripps,
via email.

Time to up-date to digital amplifier

Your last article on Digital Power Amplifiers was in 2001. Since then, digital modules have been advertised in SILICON CHIP and many of the DJ manufacturers have been selling mixers with built-in high power

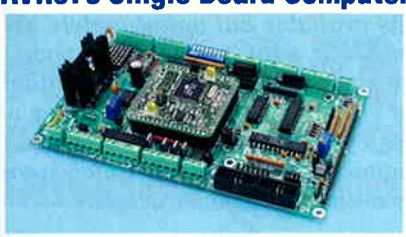
Atmel's AVR, from JED in Australia

JED has designed a range of single board computers and modules as a way of using the AVR without SMT board design

The **AVR570** module (above) is a way of using an ATmega128 CPU on a user base board without having to lay out the intricate, surface-mounted surrounds of the CPU, and then having to manufacture your board on an SMT robot line. Instead you simply layout a square for four 0.1" spaced socket strips and plug in our pre-tested module. The module has the crystal, resetter, AVR-ISP programming header (and an optional JTAG ICE pad), as well as programming signal switching. For a little extra, we load a DS1305 RTC, crystal and Li battery underneath, which uses SPI and port G.

See JED's www site for a datasheet.

AVR573 Single Board Computer



This board uses the AVR570 module and adds 20 An./Dig. inputs, 12 FET outs, LCD/Kbd, 2xRS232, 1xRS485, 1-Wire, power reg. etc. **See www.jedmicro.com.au/avr.htm**

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digital amplifiers with high quality specifications – and with very high efficiencies.

There must now be chip sets available and the scene needs revisiting with perhaps a high-power amplifier design as a result. With lower currents, getting ultra-low distortion seems a much easier task than with analog and with high efficiency.

Laurence J. Taplin,
via email.

Comment: just recently, we have done a great deal of work developing a 100W digital amplifier module which would have been very attractive, with high efficiency and low distortion. However, we repeatedly blew it up and despite several re-designs of the power supply and output filters, we concluded that its supply rail range is so tight that it just cannot be used at the power levels claimed.

Regrettably, we have decided not to proceed to publication because its reliability is too suspect for a kit project.

There are a number of other chip sets available but unfortunately they are SMDs, with very tight pin spacing, which makes them again unsuitable for kit projects. For the time being, we don't see any prospect of a practical digital amplifier module which is easily built by DIY constructors.

CFL inverter kit feedback

Several weeks ago I purchased from Oatley Electronics three CFL inverter kits, as featured in the September 2004 issue. I was impressed with the final result in the sense that it was well made. However, I found a few anomalies that may be of benefit to other users.

The first was the fact that at supply voltages slightly above 12.5V, (ie, 13.5V to 15V) the lights flickered. Analysing the circuit revealed that the feedback to the PWM IC was a chopped DC signal, which the IC was comparing with a DC level and obviously having trouble interpreting the desired result. A 10nF capacitor between ground and pin 1 solved the problem.

After leaving the unit running on a 20W light for several minutes, I found it puzzling as to why one transistor was warmer than the other. The CRO revealed different waveforms, which was even more puzzling. I then proceeded to modify one of these units for 36V operation as I could see that the primary was only four turns for 12V, so it would be simple enough to wind 2x12T for 36V.

It was then that I discovered that the two primary windings had been wound either side of the secondary. In low frequency systems, this is a clever idea as it helps to mix the magnetic flux between primary and secondary. However, in high-frequency systems it's not so good. By winding the two primaries in this way, the inductance of each coil can be quite different, as demonstrated here. Winding the two primaries bifilar fixed the problem.

At this point the units worked quite well until I discovered a problem when the unit was in full pulse width. I had used one of the PC boards as a platform to make a 1-cell lead acid charger capable of delivering around 20-25A. This was to boost a large weak cell in a solar system. Using a similar size and type ferrite, I wound a ferrite core, which only needed one turn per side on the secondary, so it was relatively quick and easy.

However, I did have a problem with the Mosfets getting hot due to voltage spikes reaching their zener point. After racking my brain for some time, I decided to consult the data sheet for the PWM IC and then tried inserting a 100Ω resistor between pins 5 & 7 to increase the dead-time slightly. The results were remarkable – the voltage spikes were reduced by a factor of about six (and hence no more heating) and the supply current dropped accordingly.

Now in the original circuit, under most conditions, this would not be a problem; only when the battery goes flat. Overall, I was impressed with the result. Keep up the good work.

T. C. Thrum,
Para Hills West, SA.

Feedback on the bed-wetting alert

I have some feedback on the Bed-Wetting Alert. Firstly, hats off to John Clarke for a very ingenious and cost-effective solution. I bought a kit from Jaycar and have the following comments.

I checked that the transmitter/receiver worked OK as suggested, however when I rebuilt the transmitter a couple of days later, I found that the system would only work at very short range. In the interim, my kids had been having quite a bit of fun making rude noises, so I checked the transmitter battery to find that it was "sagging" badly under load. I replaced it but with no real improvement. I then checked the receiver batteries and found 5V under load, which seemed workable. I then spent quite a lot of time tinkering with the transmitter, suspecting that it was off-frequency or that I had overheated Q3. Eventually I tried a new set of batteries in the receiver – bingo.

The new transmitter PC board is thicker than the old one. This is noted in Jaycar's errata which suggests using short wire links if required. I found it easier to just use new components for everything except Q1-Q3, L2 and the 1pF & 2pF capacitors.

I found the sensor strap to be way too sensitive; it would trigger with normal body moisture. Part of the problem was the way I had "sewn" the copper wire into the Velcro; it is tempting to sew with the needle exiting the Velcro loop and re-entering, in stages. This leaves small segments of copper exposed. In addition, it is impossible not to leave a small section of wire exposed on the Velcro side behind the jumper shunts.

The solution was to use an "extra" needle to nudge the "main" one through the Velcro without exiting. You need to really bury the main needle in the Velcro to ensure that the copper stays away from casual contact! When done, clip the wires about 10 mm from the end of the Velcro so that the ends remain "buried" (no need to pass them through to the other side). Now apply some clear silicone to this area and also to the area behind the jumper shunts – it seals the problem areas, leaving only the main part of the Velcro as the sensor.

The transmitter was also too sensitive. I found it necessary to reduce the 1MΩ resistor to 82kΩ to completely eliminate unwanted triggering. The receiver really needs a volume control

so that it can be set to an appropriate level. I drilled a small hole in the front panel on the bottom left of the speaker, then glued a 100Ω, 10-turn trimpot in place (when assembled the pot is positioned over a vacant area on the receiver board), wired in series with the speaker. I also found it necessary to raise the "standby" level, by changing the 1kΩ resistor associated with Q4 to 150Ω. This interacts with the trimpot setting a bit but works OK overall.

In conclusion, having used the BWA for some weeks, I would say that the biggest challenge is getting the sensor to work properly – even after building it with the utmost care and optimising the sensitivity of the electronics, there are still instances where it triggers erroneously or doesn't trigger when it should. Also, after a certain amount of usage, the copper starts to corrode or break from flexing; ie, the existing sensor design is not indefinitely reusable.

I think that the ideal sensor would: (a) cover more of the crotch area, so that moisture can trickle from any direction and it will still trigger; (b) be made of a moisture-absorbing fabric like cotton. Velcro is not ideal in this regard; (c) be indefinitely reusable or if this can't be achieved, very easy to make and therefore disposable.

Brett Crossley,
via email.

Smoke alarm false triggering

I have experienced a similar problem to your correspondent, R. B. Flaxton, on page 104 of the May 2005 issue. From time to time the alarm at one end of the hall would beep for no apparent reason, at random, sometimes in the middle of the night. Changing the battery did not help.

The manufacturers, when contacted, suggested "vacuum clean the dust off the alarm at least once a year, using the soft brush attachment on your vacuum cleaner". This seems to have fixed the problem. I trust this may be of interest to your readers.

Brian Coulson,
Balcolyn, NSW.

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GETTING INTO Wi Fi

Part 3: infrastructure, APs, PoE and much more!

by Ross Tester

When we ran out of space last month, we'd just explained how easy it was to install an "ad hoc" Wi-Fi network to wirelessly connect a few computers. Now we'll move on to the next logical step, the "infrastructure" network and connection to the world via the Internet.

Access Points (APs) are sometimes referred to as wireless base stations, WAPs, even (albeit incorrectly) as hubs or routers. You may also see terms like residential gateway or Internet gateway device mentioned. Despite the number of synonyms, as far as the wireless network is concerned, they all mean basically the same thing. Some may have more features than others, which often explains their incorrect names – eg, a WAP can have a hub or router built in.

First of all, though, if the ad hoc system works, why do you need to go to the expense of buying this extra equipment? Can't you do a lot with the simpler ad hoc network?

Yes you can, but. . .

As we briefly mentioned last month, it is possible (for example) to connect to the internet from an ad hoc network. It is also possible to set up a wireless access point using software on perhaps an old PC – that is, without buying extra hardware. But the truth is that it is not very often done – most wireless networks use the infrastructure mode with an AP. Why?

(a) it offers more features and more security than the ad hoc mode;

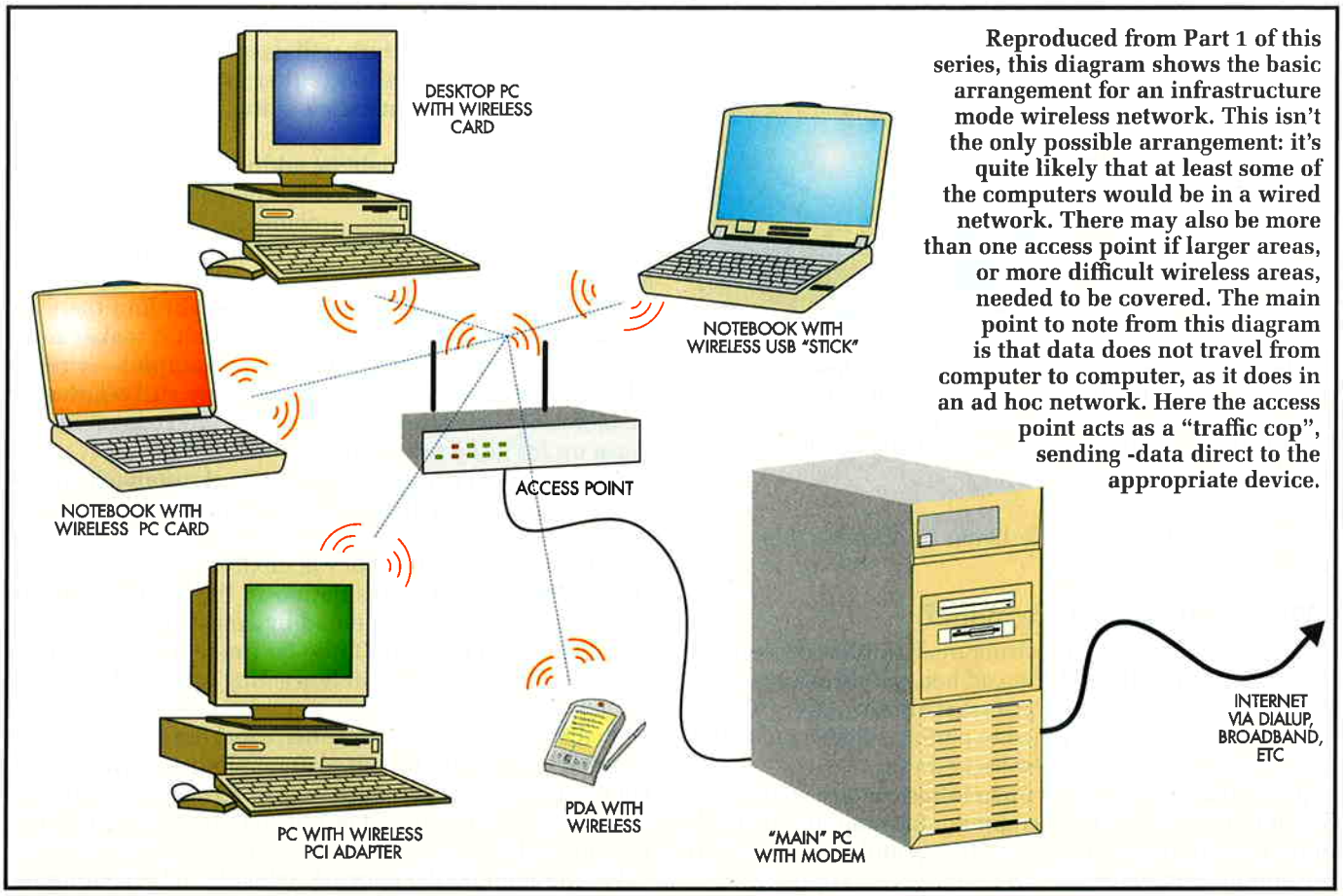
(b) it is usually much simpler to go the hardware route, especially if you want to do more than swap files; and

(c) if you only have a dial-up conenction, there are good reasons, associated with the way IP addresses are handed out, not to use a software AP.

You would normally also expect better range from an AP, if for no other reason than the AP can be mounted in a much more beneficial location. In an ad hoc system, communication is direct from the wireless network card in each computer to its counterpart in another computer.

But unless there is a (often lossy!) antenna extension cable, the antenna is normally located hard up against the back plane of the computer – it normally directly screws

Two different types of Access Points, showing both front and rear so you can see the difference. At left is a Wireless Router/AP ($179 from Jaycar Electronics) which combines the functions of an AP for wireless networks and a router for wired networks. At right is a basic Access Point ($99 from Freenet Antennas).



Reproduced from Part 1 of this series, this diagram shows the basic arrangement for an infrastructure mode wireless network. This isn't the only possible arrangement: it's quite likely that at least some of the computers would be in a wired network. There may also be more than one access point if larger areas, or more difficult wireless areas, needed to be covered. The main point to note from this diagram is that data does not travel from computer to computer, as it does in an ad hoc network. Here the access point acts as a "traffic cop", sending -data direct to the appropriate device.

into the internal wireless network interface card, or NIC. And the computer is often at floor level or hard up against a wall – hardly the best radio environment. In any event, the bulk of the computer case often provides a very effective radio shield over about 180°!

The AP too usually has integrated antenna(s) but it can be mounted well clear of obstacles, filing cabinets, people . . . we'll get back to this shortly.

Naturally, all computers on the wireless network will still have to have a wireless NIC to be able to talk to the AP (many modern laptops have them built in). But it helps to have the AP mounted in as good a position as possible to give each of those computers a fighting chance!

AP cost

With the price of all wireless hardware – not just NICs but APs as well – dropping all the time (prices have probably halved even in the last year), there now really isn't a good reason to suffer the limitations of an ad hoc system for the sake of a few pennies.

A good, "no frills" access point these days should be no more than about $100 – and possibly less if you hunt around. We've seen a lot of refurbished, guaranteed Netgear WG602 (802.11g) access points – basic but with a good reputation – being sold on Ebay lately for sub-$50 (and even less).

If you're prepared to settle for an 802.11b AP, you could pick one up for a song. Incidentally, you shouldn't notice any Internet performance difference between 802.11b and 802.11g. The limitation will be the 'net, not your AP.

Even all-singing, all-dancing AP models (such as the Linksys WAG45G wireless router, switch, ADSL modem and gateway, so you get everything you need in one package) retail for well under $200 (eg, www.freenet-antennas.com.au).

And there's the power wastage factor too: an old computer set up as a software access point will normally consume a hundred watts plus (even without a monitor on) while a dedicated access point might draw one tenth of this. While the power cost is minimal, remember these devices are usually left on 24 hours a day, seven days a week. It all adds up!

APs with two antennas

Apart from their cost, whether they are "b" or "g" models and their reputation (sometimes unearned!), one other thing you might notice about APs is their physical construction. Some have one antenna (or provision for connecting an antenna); others have two, as depicted in the diagram above.

What's the difference? APs with two antennas are almost invariably what is known as a "diversity" models. This means that a comparator of some type (usually controlled by a microprocessor) keeps monitoring the signal level at each antenna and uses the one which is picking up the best signal at that moment in time. It can – and does – switch back and forward at will, sometimes many times per second.

Because the wavelength of microwave signals is so small, they are subject to a lot of reflections, interference, etc – so the signals arriving at the two antennas can be quite different, even spaced as closely as they are.

A 20m Power-over-Ethernet (PoE) cable ($40 from Freenet-Antennas) – note the DC connectors as well as the RJ45s. This gives you the ability to provide power to your Access Point without running extra cables or looking for a power outlet at the top end.

Diversity APs are usually better performers than their single-stick cousins.

What is infrastructure mode?

Look at that name – infrastructure. It implies equipment and planning (as distinct from ad hoc, or "throwing something together"). And that's just what infrastructure mode is – a network which is planned to perform bigger and better functions and has the hardware to do so.

In a wireless network set up in infrastructure mode, data doesn't directly flow from computer to computer; instead, the access point acts like a traffic cop and directs data to the appropriate place.

It also acts as a bridge, linking the computer containing your internet connection to your wireless network. For this reason, the access point is almost invariably connected to the computer which connects you to the wonderful world wide web (wwww!).

All computers on the wireless network have their own wireless network card (which you might also called a network adaptor or even a WNIC).

We're getting just a bit ahead of ourselves here but all of those adaptors need to have the same service set identifier (SSID) so that they all know they are on the same network; they also need to have the same encryption (WEP or WPA) keys so they can actually understand each other. You set the SSID and WEP/WPA keys as part of the installation process.

Don't get too worried about all these acronyms and terms – the computer industry breeds them like no other – but most will become clear as you set things up (or you don't need to know what they mean anyway!).

Setting it up

As suggested for the ad hoc mode last month, it's always a good idea to plan your wireless network before rushing in boots and all. That way, you can get a better idea of how the various bits DO connect to each other.

It also helps you work out what you need to buy, avoiding costly mistakes. And if something doesn't work as it should (or something fails in the future) a network plan can really help in troubleshooting.

Incidentally, there's not much difference between a wireless network and a wired network from an operational point of view – if you were putting in wire instead of wireless you should do the same thing and plan it out first. The biggest difference between wired and wireless is that the speed of a wireless network will decrease as the quality of the wireless signal decreases (either by range, obstruction, etc) whereas a wired network normally keeps working until it drops out.

In some cases, you might be adding a wireless network onto an existing wired network – perfectly practical and often done. For example, a company might expand. It already has a wired network but wishes to add a few new users. Way to go: wireless!

Or even in a new installation, you might find there are a couple of computers (or more) on which it makes sense to network with wire (using Cat5e for example) – wireless NICs, even though cheaper these days, are still relatively a lot more expensive than Ethernet NICs (you can often pick those up for just a few dollars).

The combined wired/wireless network approach is often handy to remember if you get into signal problems with wireless. You might find that you have plenty of signal in one room but nothing in the next. It could be the wall construction (metal or insulation in the wall?), could be a wireless black spot (shielded by something?), could be simply running out of puff (too far from the access point). . . or it could simply be wireless acting ornery (it does that sometimes!).

By the way, brick walls are often a real drama – especially external brick walls. It's not so much the bricks themselves but the fact that bricks naturally absorb water when they get wet. And as you will find out, water absorbs microwaves very nicely!

When planning the network, consider which computer you are making the "main" computer. It's almost certainly the one which has your internet connection (eg, modem) and probably has your printer and other peripherals attached. That's the one which should also have your access point attached.

Physically locating the Access Point

The key word here is access – you must be able to access the AP itself and wireless signals also must have access. This rules out anywhere with aluminium foil-type insulation, for example (as is often used under roofs and sometimes within walls). Remember too that in many old buildings, fine-mesh chicken wire was used under tiles and in walls. Fine mesh (say 1cm or less) wire will stop WiFi signals very nicely. Plaster and brick walls are also quite unkind in many cases – and if you're sharing with next door, trees and shrubs are a no-no.

The problem with trees and shrubs is that they contain water and they also get wet (rain, dew, etc). Would you believe I have a normally excellent wifi network between myself and my next-door-neighbour which stops dead when it rains – that's when the wood paling fence between us gets wet! (If I raise my laptop above fence height, away it goes again).

If possible, keep your access point at least a few metres away from anything else which shares the 2.4GHz band – and that includes microwave ovens, digital cordless phones, some intercoms and baby monitors, wireless doorbells, home automation equipment, etc. The other gear doesn't even have to share the same 2.400-2.483MHz frequency range to severely upset your wifi network.

It also makes sense to keep the AP away from electric

motors, fluorescent lights and so on which might generate fields which upset the AP operation.

If you are linking to a wired network, the AP also needs to connect to your router, hub or switch, so it needs to be within reasonable cable distance. And finally, it also needs a source of power. That's usually not so much a problem (what else were extension cords invented for?). Or . . .

POE: Power over Ethernet

There is an excellent alternative in finding a site for your AP – and it's even more a proposition when power is a long way away, or needs to be supplied outside. It's called Power over Ethernet, or PoE, and as its name suggests, power for the AP comes over the same cable which takes signal from the AP to the computer.

In an normal Ethernet cable (Cat5e, for example), there are four pairs of wires. Two of these pairs are not normally used (pairs 7/8 and 4/5), so can be used for other purposes – like running power! It is usual that both wires of each pair are used (ie, two wires in parallel for each polarity). Even though the IEEE has a PoE standard (IEEE 802.3af) which should determine which pairs are which polarity, unfortunately many manufacturers have done their own thing and ignored the standard, so there is no hard-and-fast rule. Cisco, for example, use pairs 7/8 for +12V and 4/5 for 0V but Intel, Orinoco and others use the opposite.

Most APs are very low power devices – a few tens of milliwatts or so. But even higher power APs (up to the 4W legal limit) can be run via PoE – even the thin wires in the Ethernet cable can normally handle the required current with ease, especially as they are paralleled.

PoE-fitted Ethernet cables are readily available made up in various lengths. If you buy your cable from the same place you buy your AP, the chances are it will be correct for that AP (but don't bet the house on it!). If in any doubt, check and check again. Freenet Antennas have 20m PoE cables in the $40-$65 range (see picture) and they allow you to site the AP where you want it for optimum performance, without having to worry about finding local power.

Interference

It may seem like commonsense but one other consideration is the location of the rest of the devices on your network. If you have some "must always have on" devices, the AP location should favour those to some degree. Otherwise it makes sense to locate your AP at about the central point for all your devices. If you find you have a rock-solid signal for most devices but one or more at the extremeties suffer dropouts or slow speed, you might want to move the access point closer to them if the rest of the devices can handle it.

If you have to mount the AP in an unfavourable location (and there are times when you must), consider connecting a gain antenna to help it out. There is nothing magical about a gain antenna – you don't get something for nothing. A gain antenna merely sacrifices performance in one direction for better performance in another. The higher the gain, the more accurately the antenna must be aimed.

If your AP is at one end of the house and the other wireless devices are at the other, an antenna with some gain aimed towards the other end might do wonders.

Note that running long antenna leads is not a good idea due to the high losses of most coax cables at 2.4GHz. All coax has loss and the higher the frequency, the higher the loss. For example, common RG58 cable has a loss not too far off 1dB/m at 2.4GHz. That means you are going to lose most of your signal in the cable. Run a 10m cable and a 10dBi antenna and you are pretty much back to square one!

Some cables are available which have lower loss – for example, Freenet-Antennas have various CFD400 coax cables from 6m to 15m in length (losses from 1.3dB to 3.3dB loss @ 2.4GHz) which can be fitted with N-male or N-female connectors to order – a 6m cable with N-connectors would cost you $60.00; the 15m version $84.00.

A better answer? Mount the AP close to the antenna with a short antenna lead and use a long ethernet cable from the AP back to the computer. I can't think of a situation where you can't get away with a lot longer ethernet cable than you can a long antenna cable.

If all else fails, another AP can usually be connected to the system in a location which picks up the black spots. Or you can buy a repeater (sometimes called a signal booster) which does much the same thing. But these devices are starting to get a little outside our "simple" wifi system.

Finally, you may find that a few centimetres (or tens of) in the location of your AP (or its antenna/s) makes a lot of difference in the performance of your wireless network. Even though you have decided on the "optimal" spot, be prepared to experiment a little later on to see if you can get better range and/or speed by moving it slightly. Also remember that the antenna(s) on most APs can be rotated through about half a sphere, so don't be afraid to experiment there as well. Should we have to say it? All antennas need to be oriented, or polarised, the same way. That is, if some vertical, all are vertical – and vice versa.

Trial and error might not be the most scientific way to determine best positioning but failing some pretty fancy test gear, it might be the most sensible!

Installing the AP

This is the easy bit! Once you've decided on the location, there are two parts to getting it going: plugging it in and running installation software. As a general rule (in other words, not always!), if your AP comes with its own installation disk (CD, usually these days) it's a good idea to run that, if only to take advantage of any "extras" your particular AP might offer.

Note that some APs need to be plugged in and turned on before software installation; others require the software installed first. And some we have seen must be plugged in and/or turned on at a certain (prompted) point in the installation.

This 8dBi omindirectional collinear antenna called "The Stick" has an N-type connector and is shown here with a pipe-grip base for external mounting. However, it can also be fitted to a magna-base, which comes with 3m of low-loss coax terminated in a reverse-polarity SMA connector. (Antenna only: $70 from Freenet-Antennas).

Simply follow the instructions which came with your access point.

As we said last month, Windows XP has a very easy, very smooth installation process for wireless networks (as it does for wired networks). Simply click on to Control Panel, My Network Places and "Set up a Wireless Network for Home or Small Office", then follow the bouncing ball.

If your AP doesn't come with a disk (or you've lost it), use the Windows XP install. Later, you might be able to log onto the manufacturer's website and download up-to-the-minute installs.

Sharing your internet connection

Now that you have your wireless network up and running, you want to be able to share the internet connection over the network.

Again, Mr Gates's disciples have provided a very simple, step-by-step way to do this. It's called "Internet Connection Sharing" (ICS). If you get stuck, Windows "Help and Support Centre" will get you out of trouble.

Sharing the internet with a neighbour

Now you know that you can share the internet connection via WiFi amongst the computers on your network, what it to stop you sharing it a bit further afield – say with your next-door neighbour?

As we have said time and time again, not only is this possible, it's probable – if you haven't enabled (at least) WEP and preferably WPA (not to be confused with mobile phone WAP). Your sharing might not even be by choice!

But is it legal to share internet next door?

We touched on this in the first part of this WiFi series (May issue) but since then we've done a lot more research on the subject.

We've often heard it claimed (even since May!) that sharing an internet connection over the boundary of your property is illegal. It harkens back to the days of the Wireless Telegraphy Act of (I think!) 1906, where running any form of communications over a property boundary was specifically not allowed – mainly because when that Act was written and for maybe half a century later, "communications" involved running a wire over the property boundary.

But this is 2005 – and things have changed a little. For a start, that Wireless Telegraphy Act has been replaced (by many volumes of Acts!).

While we are only bush lawyers (whose advice is normally worth about the same as is charged for), the bottom line appears to be, at least as far as the powers-that-be are concerned, that allowing your next door neighbour to log on to your wireless network and use your internet connection for free is perfectly legal.

Note that word, for ***free***: that is, as long as you don't charge your next-door-neighbour for the privilege. If you do that, then under one of those Acts, legally you have become a carrier and require a carrier licence (and that's expensive ~$10,000!).

Of course, if you shared your wireless network with a neighbour and a slab or two of universal currency appeared on your back doorstep every couple of months – your neighbour just being friendly, of course – then that hardly counts as charging, does it?

That, at least, appears to be the official line from the Australian Communications Authority (ACA) who are responsible for administering everything to do with wireless in Australia (yes, even WiFi).

You might have read, because it is often said, that WiFi (or at least 802.11/b/g) is in the 2.4GHz "unlicenced" band – but the ACA is very quick to point out that there is no such thing in this country. Everything, even flea-powered WiFi, is licenced – it's just a matter of how!

WiFi equipment broadly fits into a class of communications gear known as LIPD, or Low Interference Potential Device. It's covered by a "class licence" which basically means you can use it as long as you (a) don't modify it and (b) don't interfere with other spectrum users. If other people cause you interference, tough luck: you are not offered any protection nor redress.

And your ISP?

OK, so that's the Government line. But what about your Internet Service Provider (ISP)? Do they like you doing it? Obviously they'd much rather your next-door-neighbour sign up for their own broadband service. In fact, some ISP contracts specifically prohibit you from sharing your broadband connection with others. Then again, some don't even mention it.

Elsewhere in this issue, I mention that I have installed the Unwired wireless broadband system. Their contract simply says, *"You must not use our Services or attempt to use our Services or allow our Services to be used by anyone else."* Gee, that's pretty tough. Anyone? What about your own family members? (It's OK, Mr Unwired. I don't share yours – my next-door neighbour shares his [wired] connection with me).

Optus cable doesn't appear to worry about it. All they say is you are responsible for any charges including extra download charges if applicable!

Check the fine print on your ISP broadband (ADSL or cable) agreement/contract to see where you stand. Whether you take too much notice of fine print is entirely up to you (it's much like all those software agreements where everyone ticks the "I agree" box at the end. If you actually read half of them, you'd be too scared to turn the computer on, let alone use the software!).

But here's the rub: by sharing your broadband connection with your next-door-neighbour, you can probably afford to go for a much better service – faster and with perhaps unlimited downloads. (Of course, once again, we'd never say something like suggesting you share costs).

But if you go for an unlimited (or even high limit) download agreement, who's to know that you haven't started downloading full-length movies or lots of music off the net? Hence your usage might . . . umm, double?

The ISP is unlikely to complain because you are paying them more for the better service!

That's my own situation. My NDN and I share his unlimited (12GB/month at full speed) broadband. He initally installed this service because he needed speed – he virtually never even made it to 1GB. A few months back, the download limit was increased from 3GB to 12GB at no extra charge (reduce the price instead? Naah!) – and even between us, we never get anywhere near 25% of that limit. And apart from my battles with the wet paling fence, it works well, too.

Gee, I must remember to buy a slab or two on the way home. Now what does he drink again . . . **SC**

CeBIT Sydney 2005

by Ross Tester

To keep up to date, we try to get along to at least a few computer and technology shows each year. CeBIT Sydney is one of them. Held during late May, the CeBIT show is arguably one of the most popular, aimed more at the business market than the "tyre kickers".

Last year, I recall saying "more of the same but different". CeBIT 2005 was similar – a lot of the latest hardware on display; software to do just about anything (and if it wasn't there, plenty of people who'd write it for you . . .) and plenty of people trying to sell you their particular gizmo or gimmick. If you were a sample CD collector, you could come away very happy indeed.

I have to say that CeBIT is not the place to go to get a bargain. Even "special CeBIT show offfer" prices were generally not much better than what you'd pay at a retail or online shop (which in fact many sellers were from, just disguised a bit!).

The two biggest things I noticed this year were Wireless and VoIP. Both were everywhere – Wireless in particular. It seemed that every second stand had something to do with Wireless – whether 802.11 variety or other incarnations such as WiMax. Antennas, connectors, cables, software, hardware . . . including a LOT of building-to-building solutions. It is very obvious that Wireless networking is here for the long haul – and for the long distance!

And there were plenty of stands offering CD and DVD duplication; others with one of last year's favourites, computer cooling.

While many of the big multinationals had large, very schmick stands with everything just so, it's often the smaller exhibitors, tucked away in corners and alleys, that have the most interesting products.

This report is certainly not meant to be an exhaustive analysis of what was on offer at CeBIT – it's more those interesting products which jumped out at me as I made my way through the four halls of CeBIT at the Darling Harbour Exhibition Centre.

Jon Reid, of **Bio Recognition Systems** (whom SILICON CHIP readers may recall wrote an article on biorecognition a couple of years ago [gad, was it really January 2001?]) had a brand new D-I-Y fingerprint access control system kit called "Bioloc" which he was launching at the show. He claims the truly weatherproof system is a significant breakthrough in both price and technology and has promised SILICON CHIP a closer look at it shortly. (www.brsgrp.com)

Just one half of one of four halls at CeBIT Sydney 2005.

Dialogue Australia had their tiny "Flybook" notebook – well, it did have a Windows XP (home) computer inside (full XP, not Tablet PC), along with a GPRS phone (all you do is plug in a mobile SIM card), Bluetooth, WiFi, GPS and a touch-screen with stylus that converts your handwriting into a text document. And all this in a 1230g, 235 x 155 x 31mm package – claimed to be the smallest in the world. And yes, it comes in six stylish colours! We hope to have a closer look at this one in the future, too. (www.flybook.biz)

Another intriguing little product was "**egrips**", a self-adhesive grip for mobile phones, cameras, etc, etc. How often have you put your phone down on a sloping surface – like the car dashboard – only to find it slide away from you?

Stick one of the self-adhesive egrips on the back of the phone and it will stay put – up to about 75° or so above horizontal. Being printable, they also make an ideal advertising medium. (www.egrips.com.au)

Travroute had the latest version of CoPilot live, a GPS navigation system for pocket PCs, smartphones and laptops which not is claimed to be the first system which not only shows you where to turn, it tells you, giving the name of the street (ie, turn left into Smith Street in 250 metres). Other nav systems may tell you to turn but only at "the next left" and so on. (travroute.com.au)

Another interesting application at CeBIT was **Powertec Telecommunication's** Ericsson Wireless Landline system for cutting business telecommunication costs. In a nutshell, it intercepts calls made to mobile numbers (a huge slice of business phone expenses these days), identifies the number being called and automatically converts the call into the lowest-cost call possible.

It does this by taking advantage of the called mobile carrier's own discounts (such as the 20c Vodafone-to-Vodafone call rate). They claim to be able to dramatically cut costs – as much as 75% and even more. (powertec.com.au)

Space does not permit mentioning a number of other exhibits that I would have liked to – and I haven't even mentioned the various country exhibitions (USA, China, Taiwan, NZ, Germany, etc) who each had a number of sub-exhibitors; nor several State Government departments, again with several companies on their stands.

If you are thinking about attending CeBIT Australia 2006 (9-11 May) allocate a full day to fully appreciate everything that's there – four hours is not enough! If you can't wait that long, CeBIT Hannover (Germany), the world's largest ICT, event is on 9-15 March, 2006. But you'd better leave a bit more than a day for that one! (www.cebit.com.au)

SC

Unleashing

Remember our article on the (then new) "Unwired" wireless broadband system back in November last year? We liked it so much we signed up for a system. Ever since, we've wondered if it could be improved . . .

Elsewhere in this issue, we report on a brief visit to the CeBIT show in Sydney. Like many of the exhibitors at that show, Hills Antenna & TV displayed a range of wireless equipment antennas and equipment.

"Ho hum, not more . . . hang on, what's this?" The item that caught my eye was a small (150mm square?) panel antenna, labelled "Show Special: 3.5GHz, 7dB External Antenna for Unwired modems. . ."

Huh? How can you hook up an external antenna to an Unwired modem?

When we looked at the Unwired broadband system we were reasonably impressed with its performance, if not its coverage. (I have to tell you that not much has changed in coverage, especially in our area).

I have installed a permanent Unwired system and even though I pay for the top (1024) service, I have never found it to even approach that speed. Most of the time, it's way under that.

Apparently, the reason for the slow speed is that I am right on the edge of the Unwired service area. All I ever get is the "red" indicator LED – they say that means good, even though it's the minimum usable signal level. An orange LED means very good, a green LED excellent. Not that I have ever seen those colours. (The LEDs would probably be better labelled marginal, reasonable and good).

The antenna on the Unwired modem is semi-fixed. Called a "rabbit ear" for obvious reasons, it can rotate through 180° but that's all.

Unlike their opposition (iBurst) wireless modem, there is no provision for an external antenna on the Unwired modem. (While it's true iBurst include an external antenna socket, so far no-one has come up with the appropriate plug to actually connect to it!)

I had toyed with Stan Swan's idea of a WiFri antenna, mounting the Unwired modem so its antenna was at the focal point. Somehow, I never quite got around to doing it . . .

At CeBIT, I got to chatting to Rolf Roelfsema, Hills Antenna's Microwave Product Development Manager. I asked him about that external Unwired antenna and also about the apparent inability to plug it in!

Almost conspiratorially, he replied "If you – ahem – remove the rabbit ear you'll find it plugs into a standard MCX connector. So if you want extra range or a boost in performance, you can easily do it."

"How can you remove the rabbit ear? There's not a screw nor a clip anywhere on the modem that I could find."

"It's really easy once you know how," he said – and then explained how to do it!

"What do Unwired think of this," I asked.

"Unwired don't condone it," he said. "In fact they say you void the warranty if you remove the rabbit ear. . ."

Incidentally, I understand that since CeBIT, Hills plan to start talking to Unwired to "legitimise" what is obviously a win-win situation for both companies .

We then started chatting about other antennas they had which would do an even better job than the tiny panel antenna they were offering.

"This panel (the one on display) gives a bit better performance than the rabbit ear but Hills has a range of 3.5GHz antennas which will give you

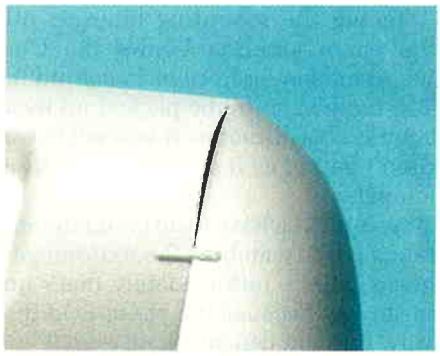
Here's the Hills BC7243 13dBi flat panel antenna, similar to the smaller one that caught my eye at CeBIT. This one would be all most Unwired users would need.

Unwired

by Ross Tester

The trade secret: how to remove the Unwired "rabbit ear" antenna to reveal the antenna socket underneath!

Here's the Unwired modem with the rabbit ear closed. See those two little raised marks on the seam . . .



line them up by rotating the ear, just like this, and you should find that the antenna can be pulled out and off. . .

revealing the standard MCX antenna socket inside. It's a push-in type, not a screw-in type.

far better results," he said. "Once the madness of CeBIT is over, why don't you come out to Hills and we'll go through what is available."

So it transpired that a week or so later I made the cross country jaunt to Riverwood (a good hour's drive away from the SILICON CHIP offices) and met up again with Rolf.

There he showed me a range of antennas, some of which had started life as 2.4GHz WiFi models but had been adapted for the higher frequency (3.5GHz) Unwired.

Two in particular stood out. One was not too dissimilar to the antenna I'd seen at CeBIT: a low-profile flat panel antenna, 190 x 190 x 20mm, suitable for outside or inside use, pole or wall mounted (or, as Rolf pointed out, can sit flat on a desk or filing cabinet, etc).

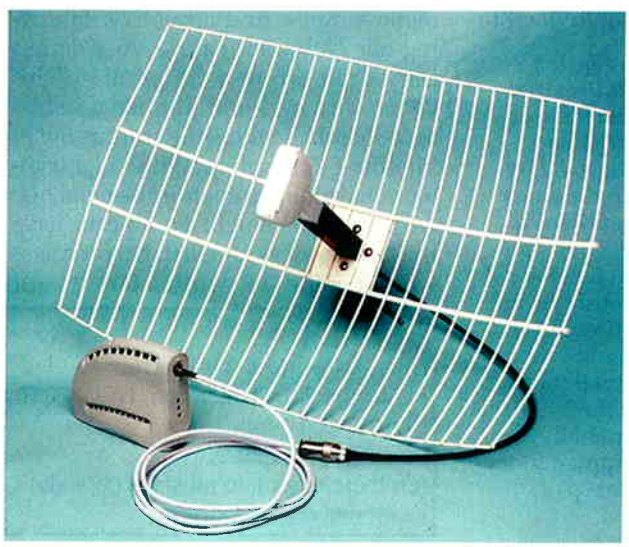
With a gain of 13dBi, this antenna has a horizontal and vertical beamwidth of 35° so is not just high gain, it's also rather forgiving of aiming errors – close enough is probably good enough.

It has a UV-resistant ABS radome and aluminium backplate, mounted on a diecast aluminium bracket and is suitable for horizontal or vertical polarisation (though as an Unwired antenna would be vertical).

An integrated type-N female socket connects to the outside world.

The second antenna was a more traditional parabolic grid "dish". This one, according to Hills, will normally lift your Unwired signal level up two LEDs and often gives you wall-to-wall signal even in otherwise dodgy areas. Hey, sounds like my Unwired service!

The rugged, powder-coated grid antenna is actually available in three sizes, with 16, 19 and 25dBi reflector options. Naturally, the higher the gain, the less forgiving the antenna will be about aiming – the 25dBi model only offering 10° horizontal and 8.2° vertical beamwidth. Still, for someone with signal levels down in the mud, a few more minutes up a ladder getting the aim just right is hardly going to matter in the long term.



And this is one of Hills' big guns, a 16dBi powder-coated parabolic grid antenna (Part No KC4253) which plugs into the Unwired modem via a downlead (black) and patch lead (white in this case). Other (larger) models have even higher gain. This antenna is a little bent out of shape (it's been doing the rounds of the shows). But it still works perfectly – in fact, I couldn't stop it working no matter where I aimed it!

Connecting the antennas

Connecting any antenna in the GHz range is always something of a challenge – and both these antennas proved to be just that. It's a compromise between location (and that means distance) and loss. But, as they say in the classics, where there's a will, there's relations. Woops, sorry, wrong proverb.

The panel antenna outputs to an integral "N" female connector. The grid antenna outputs via a 600mm coax downlead, terminated in an "N" male or female connector.

The Unwired connector mates to an MCX plug and this, at the moment, can only be fitted to RG58 coax. Now as any amateur radio operator will tell you, RG58 is at best marginal at upper HF, very lossy at VHF frequencies. . . and at 3.5GHz it's hopeless.

So only a very short length of coax can be used (we tested it with 2.5m). That's fine for one popular method of mounting: the antenna and Unwired modem in the roof cavity (ie, under shelter), with the modem connected

These two adaptors from Hills allow direct connection between the panel antenna and the Unwired modem.

via a longer Ethernet cable. But it's not too realistic if you want to mount the antenna outside and the modem inside. Hills are working on that little dilemma and expect to have a solution available even before this issue hits the streets.

A possible alternative for the panel antenna is direct (ie, no coax) connection using a couple of adaptors which Hills have as standard stock lines. Just like WiFi access points which we talk about elsewhere in this issue, it's no big deal to mount the Unwired modem in the ceiling and run a Cat5e patch cable back to your computer. You could even run PoE (Power over Ethernet) to the Unwired modem if you were really keen.

You could do the same thing with the grid antenna by connecting the appropriate adaptors to the (fitted) coax cable. Of course, both of these options are null and void if you have aluminium-backed insulation in your roof/ceiling or you have a very old or very new house with corrugated iron roofing (isn't it funny how we used to despise corrugated iron!).

Doin' it!

First we will look at the panel antenna. As our close-up photos show, two adaptors are used to go from the male "N" connector to the Unwired modem. These are a MCXto RPSMA (Hills part no BC7240) and a RPMSSA to "N" (male) (Hills part no BC7263). Note that the Unwired socket is a push-in, not a screw-in type.

Taking the mounting brackets off the panel antenna allows the Unwired modem to fit right in behind it. The modem could be packed up by a couple of millimetres if you wish; we didn't bother as it seemed to be close enough.

Now all you have to do is aim the antenna while watching the red/orange/green LEDs – unfortunately that's no mean feat because the panel is in the way. But you can see them – just!

When you get the best operation, set the antenna and modem in that position and you're ready to see how much better/faster/both your Unwired signal is.

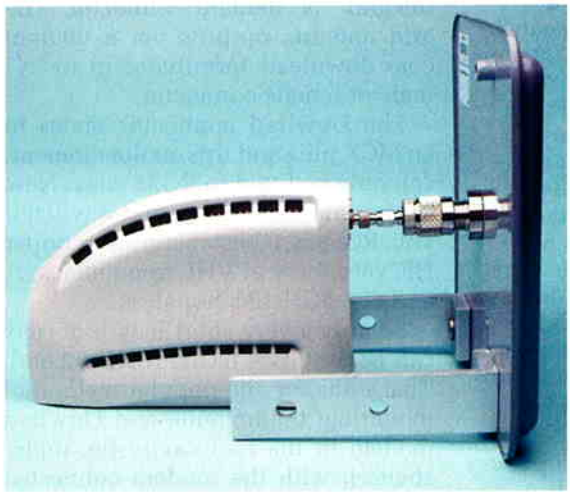
The grid antenna is both a little easier and a little more tricky. Because it comes with both a downlead and a modem extension cable, siting it isn't quite as difficult. But as we said before, it's a lot less forgiving when it comes to aiming it. Still, 16dBi gain means you should have a lot more signal to play with – the optimum point of aim will just be that much tighter.

External mounting

If you need to mount the system outside, you may be able to get away with the 480mm downlead and the 2.5m patch lead we tried – especially if you mount the Unwired modem close to the point where the lead comes in from outside and run Cat5e back to the computer (similar to the panel antenna above).

Otherwise, you're going to need to get some very low loss antenna patch leads. They are available but they're not cheap. Don't go for any longer than you absolutely need because every extra metre means more lost signal. Remember too that while N-connectors are designed to be low loss themselves, every extra connector in the system introduces more loss.

Of course, you could ferret out some low-loss coax and connectors to make up your own patch leads – but that's probably not worth your while.



With those two adaptors shown above, the Unwired modem can connect directly to the BC7244 panel antenna as shown here. They are not *exactly* in the same vertical plane – perhaps a milli-metre or two out – but they are close enough for us! This would obviously be an "inside" installation but if some form of suitable weatherproofing was available (only needed for the Unwired modem, not the panel), we might even be tempted to try this setup outside!

OK, how did they go?

It is still early days yet but both antennas gave a significant boost to my Unwired signal.

For the first time, I'm seeing signal strength LED colours other than red – the panel antenna gave me an orange and the grid antenna, aimed correctly and above the insulation inside the roof, always gave a solid green. (In fact, aimed *anywhere* – 180° from the nearest Unwired tower, even straight up in the air or straight down, it always gave at least as good performance as the rabbit ear!)

And speed also seems to be increased. I haven't really had the chance to review it for a long period nor in all weathers – the forecast is for a wet weekend (rain used to knock my Unwired around a bit!) so that will be interesting.

I'm happy: the antenna investment is well worth it. Unwired isn't the cheapest service so you really need to extract every bit of performance that you can. For the sake of well under $100 (panel antenna, including adaptors) or a bit over $100 (grid antenna and patch lead), your sluggish Unwired service can really start to sing.

One other benefit which some readers might find attractive: following our Unwired feature, Av-Comm's Gary Cratt wrote a coupe of articles about Unwired and similar wireless broadband knocking the stuffing out of satellite TV reception. With a highly directional antenna such as the parabolic grid, you just might be able to have the two services co-exist. No promises – but it could be worth a try! **SC**

Contact:
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12 Wiggs Rd, Riverwood, NSW 2210.
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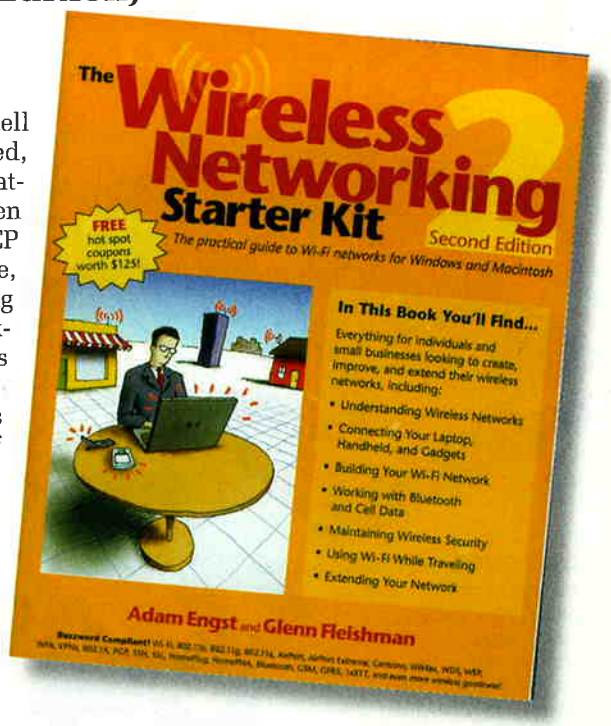
BOOK REVIEW

by Ross Tester

The Wireless Networking Starter Kit (2nd Edition)

by Adam Engst & Glenn Fleishman, Peachpit Press (US), 530+ pages, soft cover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• Using Wi-Fi While Traveling
• Extending Your Network
Adam Engst and Glenn Fleishman

Some months ago, I asked our non-resident Wi-Fi guru, Stan Swan, which book he would recommend for a beginner in the field of Wi-Fi (at the time, me!). "None better than The Wireless Networking Starter Kit," he said.

Now that's some recommendation. So I contacted the publishers and organised a copy. If it was as good as Stan said it was, we'd like to put it in the SILICON CHIP bookshop.

In due course, the book arrived – and my first surprise was to find that there was now a second edition. My second, hardly a surprise, was to find that Stan (once again!) knew what he was talking about.

This book is one of the best Wi-Fi resources I have found – and by now, I've seen quite a lot of them.

You *might* be able to find a lot of the information in this book on the 'net – if you have the time (lots of!) and patience (even more!) to go searching for it. In the Wireless Networking Starter Kit, it's all there in one handy reference volume. And at the price, it's very good value for money.

Covering both the Windows and Mac environments, it starts with the real basics – how wireless works, the standards, the hardware and so on, even looking into the crystal ball at the (near) future of wireless.

In some respects, their prophecies are already coming true – the book was written during mid 2003 so now, two years on, we can see how right the authors were. (They were!).

It then moves on to the "nuts and bolts" of wireless networking: how to connect your computer and then building a wireless network. By the time you've read through all of this, you should have a very good idea of just what you need and how to string it all together. In fact, you'd probably rate yourself as a power user, if not an expert.

Wireless security is covered in some depth. Given the importance of this subject in the 21st century, this is a welcome sight. Not only does it tell you how you can be attacked, it tells you how to prevent attacks in your network. It even tells you how and why WEP encryption is so vulnerable, even going as far as detailing the software capable of breaking WEP. Why? Forewarned is forearmed!

The authors then discuss mobile Wi-Fi in a variety of formats. While some of the information is US-specific, it was very interesting to me to read just how and why the various systems evolved and are still evolving. Finally, they talk about long-range Wi-Fi – how to get long distance from a Wi-Fi installation.

There are three useful appendices, too: networking basics, configuring your network and settings, and most importantly, how to troubleshoot. Finally, a glossary fills you in on all the Wi-Fi buzzwords.

Criticisms? A couple of minor bits of JISP (jumbled interpretation of scientific phenomena). An example: "In the simplest terms, an antenna increases the power of a transceiver.. ." (P32). Umm, no it doesn't – we think they meant to say an *external* antenna increases the radiated power of a transceiver, which still isn't strictly true but it imparts some meaning to readers not versed in RF.

They also talk about the US FCC worrying about people connecting "too powerful antennas" which again is misleading. No antenna is any more "powerful" than another because they don't have "power". It might be more efficient; it might have higher gain by increasing performance in certain directions and sacrificing performance in others. But more powerful, it ain't!

However, if these quibbles are all we have to report, the authors have done very well indeed in explaining what is still a black science to most people, including many computer users.

What we did like is the continuous notes and asides through the book. Did you know, for example, that spread-spectrum technology (the basis for Wi-Fi transmissions) was invented during WWII by the actress Hedy Lamar and kept secret by the US Government? Neither did I!

And the opening quote in the book, attributed to Albert Einstein, really tickled my fancy: *"The wireless telegraph is not difficult to understand. The ordinary telegraph is like a very long cat. You pull the tail in New York and it meows in Los Angeles. The wireless is the same, without the cat."*

For more information on this book (even a "teaser" downloadable chapter) go to **www.wireless-starter-kit.com.**

The Wireless Networking Starter Kit is distributed in Australia by Penguin Group and should be available (probably to order) from better bookshops, with a recommended retail price of $49.95.

It is also available from the SILICON CHIP bookshop (online or through the magazine for $48.00 plus $7 p&p).

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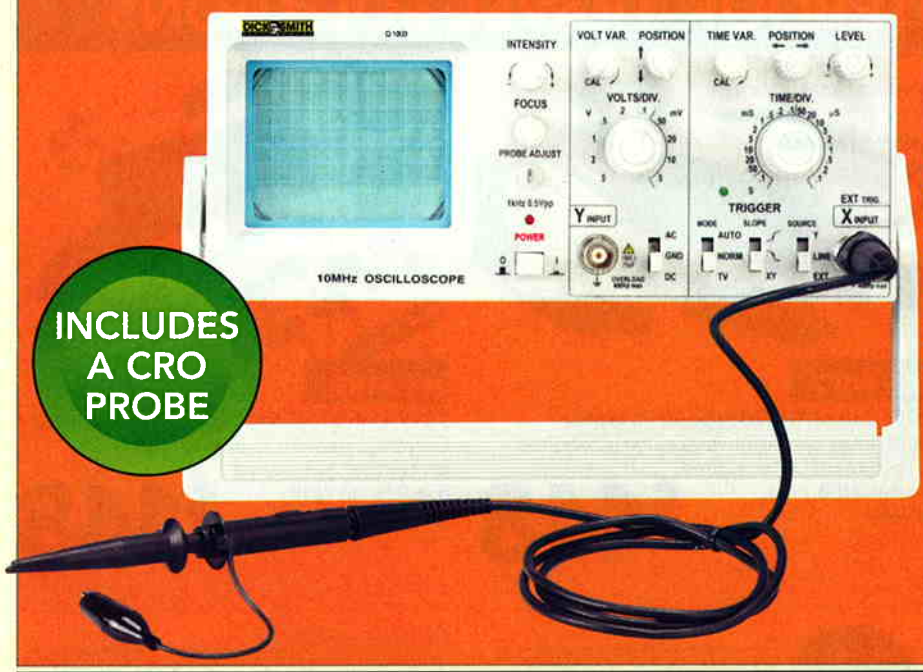

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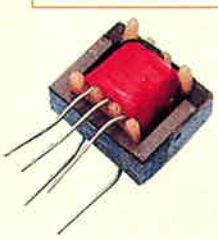

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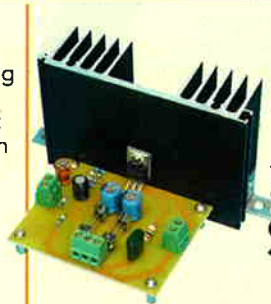

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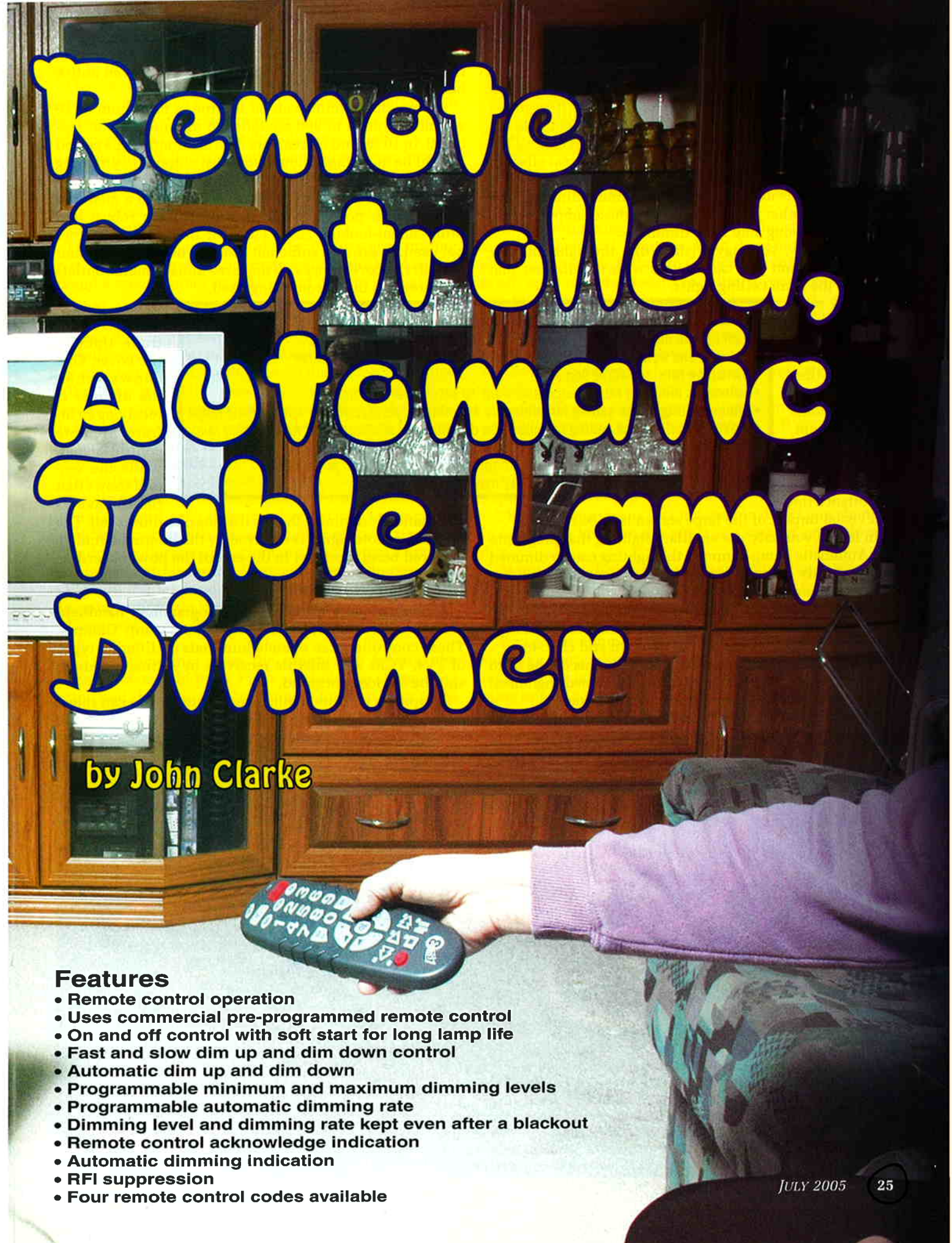
Plug in any lamp – dim up or down remotely and automatically

Remote Controlled, Automatic Table Lamp Dimmer

by John Clarke



Features

- Remote control operation
- Uses commercial pre-programmed remote control
- On and off control with soft start for long lamp life
- Fast and slow dim up and dim down control
- Automatic dim up and dim down
- Programmable minimum and maximum dimming levels
- Programmable automatic dimming rate
- Dimming level and dimming rate kept even after a blackout
- Remote control acknowledge indication
- Automatic dimming indication
- RFI suppression
- Four remote control codes available

Do you want more features from a plug-in lamp than just boring old on and off?

This multi-featured Automatic Lamp Dimmer provides total control via an infrared remote. Use it for mood lighting, home theatre lighting or even as a night light.

Wall-mounted lamp dimmers (ie, those that control the fixed lamps in homes) are common, used to great effect to adjust the brightness levels to suit the occasion.

However, it is not very common to find a dimmer for a table lamp or other portable lamp. But these lamps can also benefit from being able to be dimmed.

For example, you may wish to dim the lights in your lounge room and you can do this with the dimmer that controls the main ceiling lights.

Until now, though, you've had only on and off control of any other lamps.

For a home theatre room, being able to dim the ancillary lights is important if the full visual impact of the large screen is to be realised.

In fact, if you only use ancillary lighting that plugs into the Automatic Lamp Dimmer, the lighting can be dimmed automatically over the period of a few seconds, resulting in a "professional" theatre experience.

And as the dimmer functions are remote controlled, all the brightness adjustments can be made from the comfort of your lounge chair. Bring on the popcorn and choc-tops!

As a night-light, the Automatic Lamp Dimmer can be set to slowly dim from full brightness (or from a dimmed brightness) down to a preset level over an extended time period.

The slow dimming function is ideal for use in a child's room. It provides such a slow reduction in light over a period of time, that the children probably won't even notice before they fall asleep!

Automatic dimming can be set from a minimum of 10 seconds through to 990 seconds (16 minutes and 30 seconds), in 10 second increments. The maximum time period should be more than enough for most automatic dimming applications.

The Automatic Lamp Dimmer is housed in a modified 4-way mains power board. This provides a robust and professional-looking case. Three of the four outlets are not used, to provide sufficient space to house the dimmer circuitry. A cover blocks off the three unused mains outlets and prevents these from being used.

Specifications

- **Fast up and down dimming** ... *2 seconds from one extreme to the other*
- **Slow up and down dimming** ... *12 seconds from one extreme to the other*
- **Switch on rate** ... *340ms soft start*
- **Automatic dimming rate**... *adjustable from 10 seconds to 990 seconds*
- **Minimum brightness setting for automatic dimming** ... *adjustable over full dimming range*
- **Maximum brightness setting for automatic dimming** ... *adjustable over full dimming range*
- **Maximum dimming steps** ... *125*
- **Phase control range** ... *14° maximum brightness, 158° minimum brightness*
- **Lamp rating** ... *40W minimum to 150W maximum*

Two indicator LEDs protrude through the cover. One shows when the dimmer is receiving an infrared remote control signal, while the second shows that the dimmer is automatically dimming (handy if a long dim time is set). The infrared remote signal is received by the internal circuitry via a red bezel mounted in the end of the power board.

The infrared remote

A commercially available, pre-programmed handheld remote control operates the Automatic Lamp Dimmer. These controllers can operate hundreds of different types of TVs, VCRs and satellite receivers by setting a code to suit the device concerned.

To operate the Automatic Lamp Dimmer, you can select one of four programming codes. The idea is to use a code

Our new Automatic Lamp Dimmer is housed in a 4-way power board, modified to suit the inclusion of the PC board. Three of the outlets are not used and are blanked off by the "front panel". At right is the commercial infrared remote control we used, a "Big 3" from Jaycar Electronics. Most "universal" remote controls would be suitable for use with the Automatic Lamp Dimmer and can probably replace a couple of your existing remotes into the bargain!

that does not operate any of your other devices that are used in the same room.

The remote control can also be used to operate your other remote control devices such as TV, VCR and cable/satellite receivers. More elaborate pre-programmed remote controls will operate DVD players and amplifiers as well.

As mentioned, the Automatic Lamp Dimmer can be used to control the light in several ways. Simple on-and-off switching of the lamp uses the mute button on the remote control. Press this and the lamp switches on; press again to switch off.

Think of this operation as similar to the sound muting on a TV set – a press of the mute switch turns the sound off and a second press sets the sound back to normal.

Soft starting

When the lamp is switched on, it may appear that it is instantly switched to full brightness. However, in reality it is soft-started. Soft starting means that power is applied to the lamp gradually. This reduces the very high surge current flow that would otherwise occur due to the lamp's filament being cold. Allowing the lamp filament to warm up more slowly prevents most of the thermal shock most lamps experience, resulting in a much longer life.

The soft start brings the brightness of the lamp up automatically from off to full brightness in 340ms. That's just a third of a second, so in all probability you won't even notice the difference between this and normal off/on action.

By default, the lamp must be soft-started when using the remaining controls for the Automatic Lamp Dimmer. This is because the brightness is brought up slowly using the dimming buttons on the remote control.

There are three types of dimming available for the lamp.

(1) Fast dimming, using the channel up (+) and the channel down (-) buttons. Press and hold the channel (+) button and the lamp will be dimmed up from fully off to fully on in about two seconds. You can stop the dimming

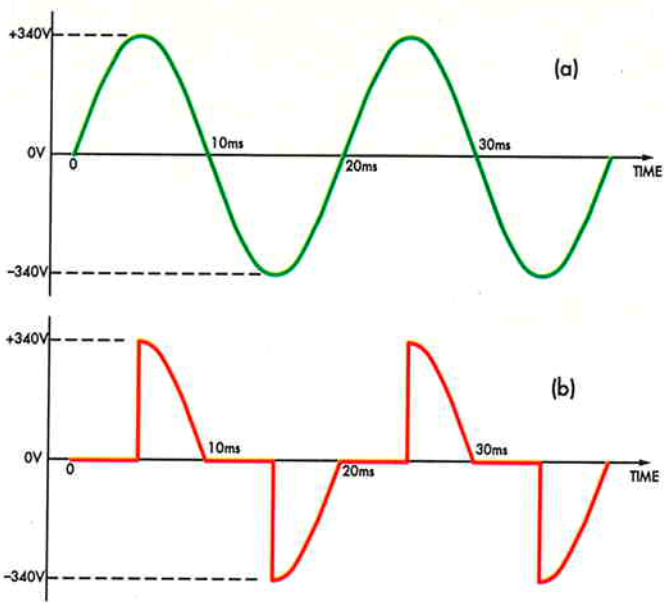


Fig. 1 depicts phase control of an alternating voltage. Fig.1a shows the normal AC waveform (ie, that from the power point). Fig.1b shows just what happens if the power is applied for half of each half cycle.

NOTE: THIS CIRCUIT CAN BITE!
Never plug this project in to mains power without the case fully assembled. Contact with components could be lethal.

at any brightness level by letting go the button. Similarly, the channel (–) button will dim the lamp from fully on to fully off over two seconds.

(2) Slow dimming is available with the volume up (+) and volume down (-) buttons. With these buttons, it takes some 12 seconds to fully dim the lights from off to on or on to off, again with the position holding if you let go the button. Slow dimming allows you to select precise brightness levels for the lamp if that's something you need to do.

(3) Automatic dimming is initiated with the operate (or standby) button. This is usually the red button and it has a split circle and vertical stroke icon to indicate a power switch.

During dimming, the lamp will dim up or dim down with 125 steps in brightness level from full on to full off over the automatic dimming sequence. Dimming will alternate between dimming up to dimming down with each pressing of the operate button at the end of the dimming sequence.

The 125 steps means it is not easy to detect any change in brightness level, so the effect is a smooth up or down dim.

At any stage during the automatic dimming sequence, the other dimming or on/off controls can be used to stop the dimming sequence and begin the operation selected by the appropriate button.

Two preset dimming levels, high and low, can be set to suit your particular application. A preset high dimming level sets the brightness reached when automatically dimming up and a preset low level sets the brightness reached when automatically dimming down. The preset brightness levels can be set to any value required.

For example, the preset low level would be set to a low glow from the lamp filament, suitable for sleeping. Or it might be set higher, for home theatre use. Similarly, the preset high level could be set anywhere you desire.

The preset levels are selected by setting the required

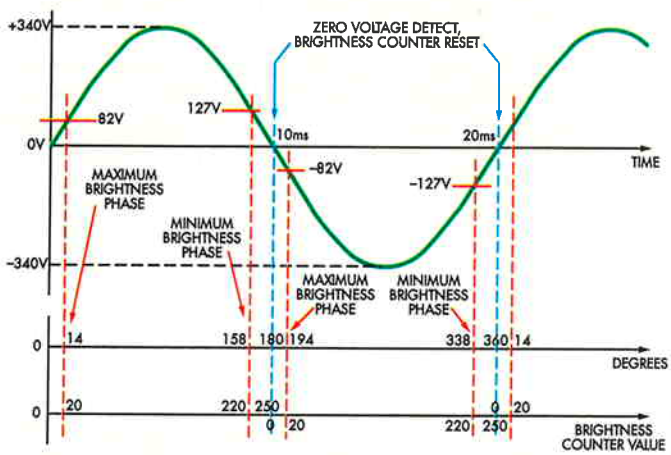


Fig.2 shows the relative trigger points and corresponding voltages used in the automatic dimmer. A full explanation of these is in the text.

brightness level with the slow dimming controls - the level set during slow up-dimming will become the high preset level and the level set during slow down – dimming will become the low preset level.

The levels are only set during slow dimming, not during fast up and down dimming. If you want to set the preset levels for automatic dimming, you set them using the slow dimming, then press the "operate" button followed by the "0" button on the remote control. The "0' button tells the Automatic Lamp Dimmer to store the new high and low brightness levels that were selected during the slow dimming.

This is a two-stage operation for storing the required preset brightness level. It prevents any dimming made using the slow dimming controls from becoming the new preset brightness level unless it is stored using the "0" button during automatic dimming.

For obvious reasons, the low brightness preset should not be set at a higher level than the high preset level nor vice versa. If this happens, automatic dimming will not work.

The rate of automatic dimming is programmed during automatic dimming using the number buttons on the hand-held remote. One or two numbers can be entered, ranging from "1" through to "99", which correspond to 10 seconds per digit. So, for example, entering a "1" will cause the automatic dimming to occur over a 10 second period. Entering "10" will set a 100 second (1 minute 40 seconds) automatic dimming period and so on.

Note that the number "0" cannot be entered first because that is used for preset brightness storage. "0" can be entered as the second digit for the automatic dimming rate.

Once the automatic dimming rate and the preset brightness level values are stored, they will remain with these settings unless changed again. The settings will remain even if there is a power blackout or if the Automatic Lamp Dimmer is switched off at the mains.

The first time power is connected to the Automatic Lamp Dimmer, the lamp will initially be set to off.

Acknowledgement

Whenever the Automatic Lamp Dimmer receives an infrared remote control signal, the acknowledge LED will flash on and off at a rapid rate. It will do this for any remote control code whether it is the correct one or not.

During automatic dimming, the auto dimming LED will flash at a one-second rate. This is very useful when the dimming rate is set to a long period, since the LED then indicates that the sequence has started even though it is not noticeable by the dimming of the lamp. It also indicates that the preset dimming level can be set and/or the dimming rate can be programmed, if required.

If a number is pressed, the auto dimming LED will flash rapidly for around 0.5 seconds to show that the number or dimming level has been recorded. The second number can be entered when this rapid flashing of the LED has stopped.

Also, it is possible to enter the "0" to record the dimming levels, then two other numbers to record the dimming rate if both values are to be changed. Alternatively, just the dimming rate (eg, 25) can be entered or just the dimming preset level using the "0" can be entered on their own.

Phase control

The lamp brightness is controlled by a phase control circuit.

When a lamp is driven from the full mains supply, the filament is supplied with current from 240V AC. 240V is the "rms", or root-mean-square, value of the AC waveform. Incidentally, it equates (in a resistive load such as an incandescent load) to exactly the same amount of applied power as would be applied by a DC (direct current) source. Put another way, a light globe will be exactly the same bright-

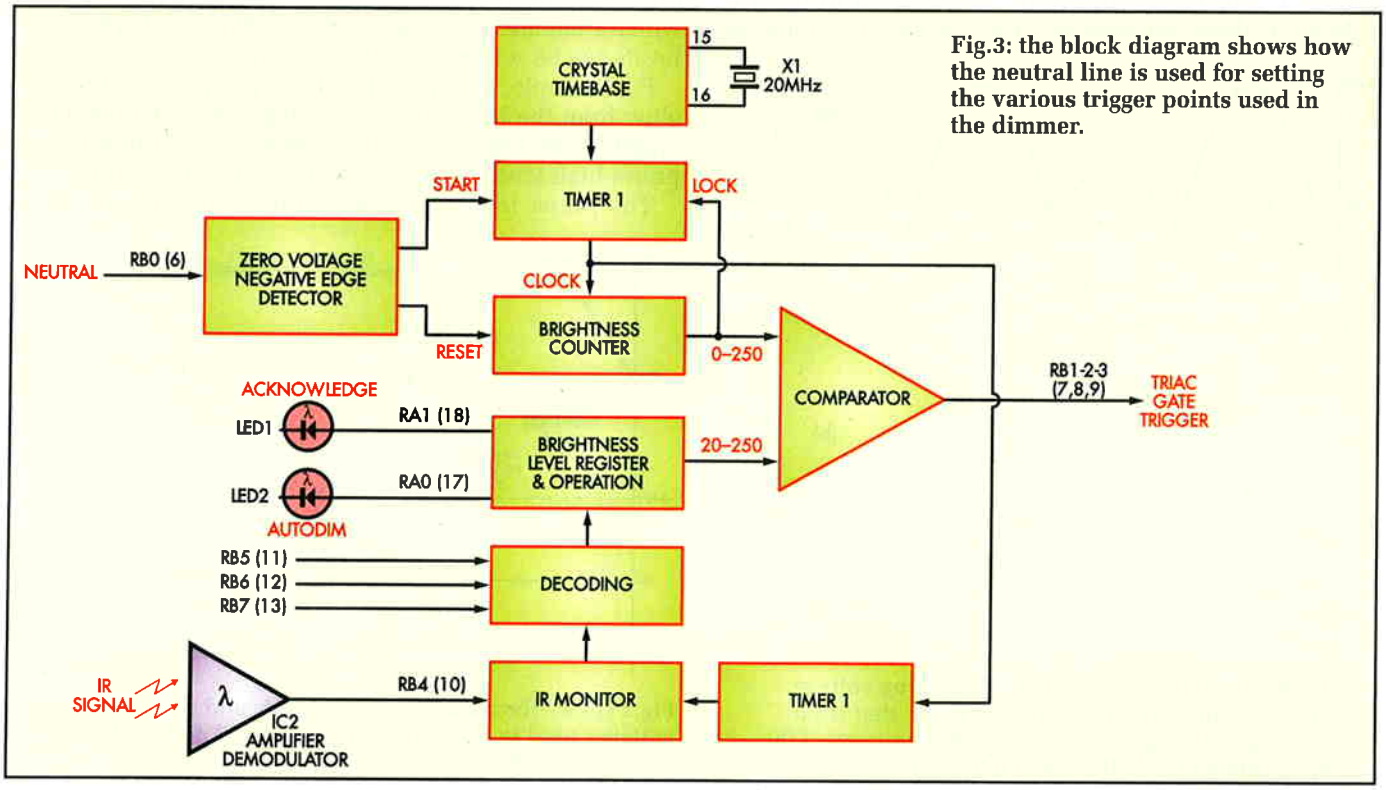


Fig.3: the block diagram shows how the neutral line is used for setting the various trigger points used in the dimmer.

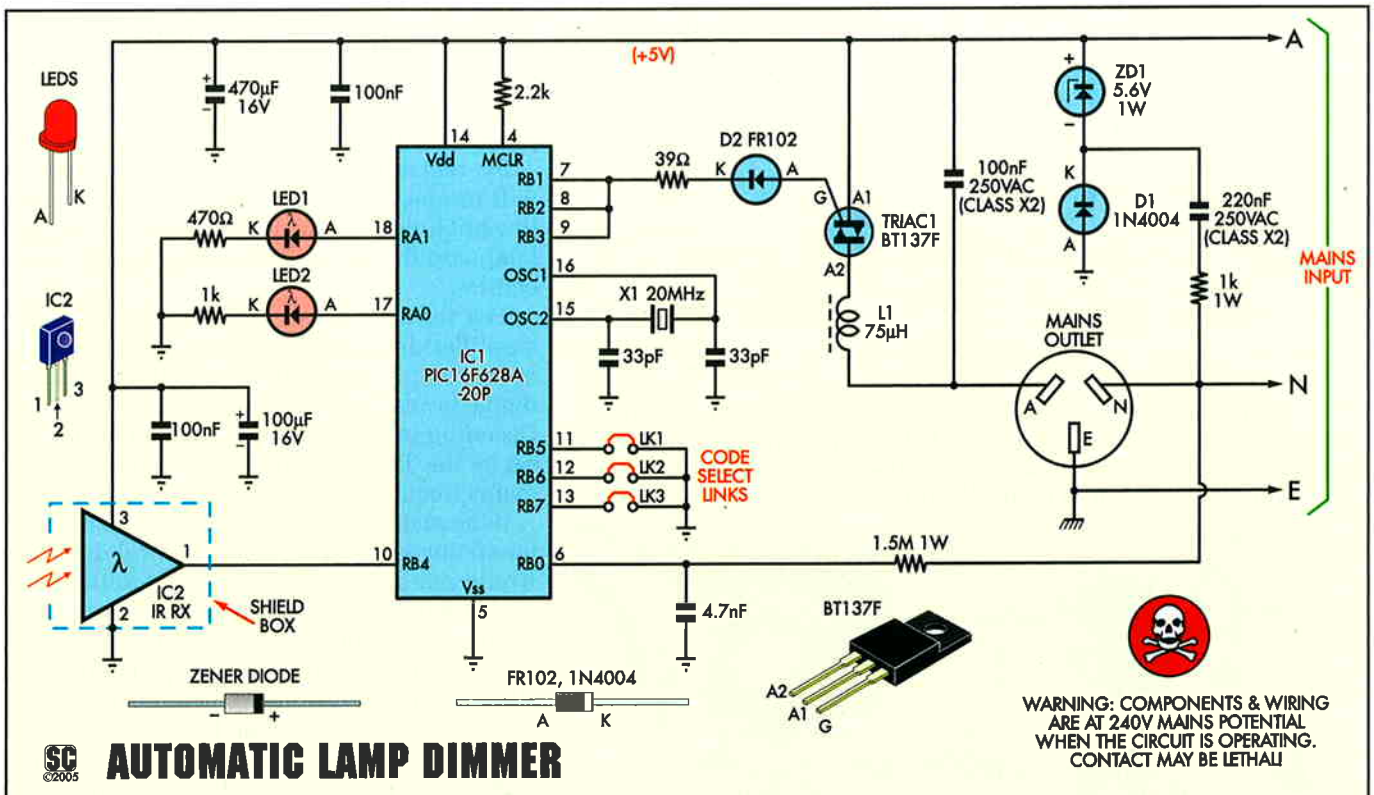


Fig.4: here is the complete circuit. A PIC16F628A handles most of the hard work. Please note the warning above!

ness powered by 240V rms or 240V DC.

The peak value to which the AC voltage rises is significantly more than the rms value – in fact, it's exactly 1.4142 times – or about 340V. (It's *about* 340V and not *exactly* 340V because 240V rms is what the electricity supply authority aims for – but it can be ±5% so could actually be anywhere from about 228V to 252V).

For a 240V AC supply, this means that the voltage will swing from 0V up to around +340V before dropping to zero again. The voltage then swings negative to –340V before going back up to 0V again. The whole process repeats in a sinusoidal waveform at a frequency of 50Hz.

Why 50Hz? Because that is the carefully-controlled but again average frequency at which the power is generated back at the power station.

If the voltage is only connected to the lamp at say when the voltage is at 340V, the supply to the lamp and hence its brightness will be greatly reduced as shown in Fig.1b. This is because power is only applied to the lamp for half the time – the first part of the "cycle" is wasted.

The supply to the lamp is switched off again when the voltage drops to zero. This happens because we are using a Triac to do the switching and Triacs turn themselves off when the voltage (or more correctly the current) drops to zero – see Fig.1.

This method of lamp dimming is called phase control. By altering the point in the cycle where the voltage is applied to the lamp, we can provide dimming from fully off through to fully on. Fully off is where the lamp is never provided with current, while fully lit is when the voltage is applied to the lamp at the beginning of the mains cycle. Dimming levels in-between the full brightness and the fully off range can be set by switching the lamp on at a time other than at the beginning of the mains cycle.

Circuitry for the Automatic Lamp Dimmer uses phase control and divides up the each half of the mains waveform into 250 discrete sections – 250 between the 0° to 180° positive half cycle excursion and 250 from the 180° to 360° negative half cycle.

Each discrete section corresponds to about 0.72°, as shown in Fig.2. The two extremes over which the circuit will dim the lights are from 14° through to 158°. The 14° setting gives maximum brightness (ie, lamp fully on) and the 158° provides the minimum brightness (lamp fully off) phase setting.

Why not 0° and 180°?

The reason for limiting the dimming range between 14° and 158° is to ensure that the lamp is not switched in the previous half cycle or into the next half cycle. This could happen with a wider dimming range because the zero voltage crossing detection has a degree of uncertainty due to filtering that produces phase changes. Tolerances in the filter components will alter the phase and hence the zero voltage detection point in the mains waveform.

Block diagram

Fig.3 shows the general arrangement of the automatic dimmer circuit. Most of the operation, with the exception of the infrared amplifier demodulator (IC2), is performed by a PIC16F628A microcontroller, programmed to perform phase control (IC1).

It accepts inputs from the mains and from IC2 and provides an output to drive the gate of a Triac.

The mains Neutral input (pin 6) provides the phase information. Each time the voltage goes negative, the micro-

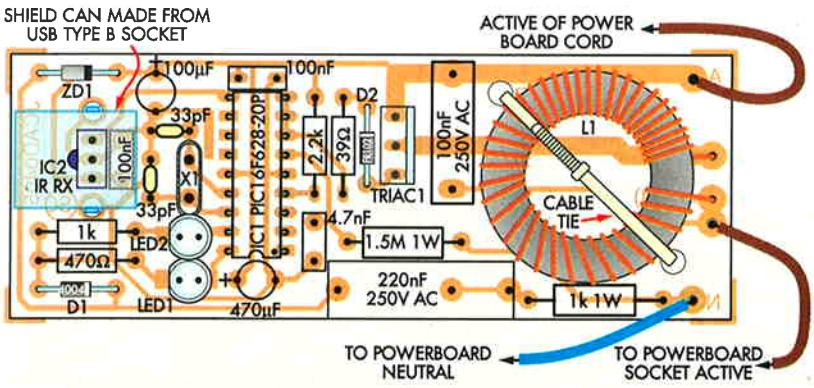
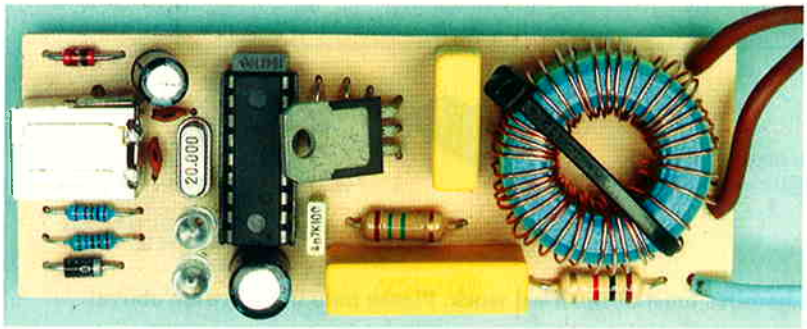


Fig.5: all components are mounted on a single PC board which in turn is housed inside the powerboard case. Below is a same-size photo of the board from above. Note that the Triac (centre of picture) is bent over about 40° to allow it to fit inside the case.



controller senses this and so is provided with a reference position for the phase of the mains waveform.

The zero-voltage negative-edge detector resets the brightness counter whenever the voltage is zero. After resetting, the brightness counter is incremented by 1 every 40µs from 0 up to 250. By the time the count reaches 250, some 10ms has elapsed which is half the wavelength of the mains cycle, the zero voltage crossing point for the second half cycle.

The 40µs brightness counter is clocked from timer 1, driven by a 20MHz crystal time base. It is important that the brightness counter reaches the count of 250 exactly at the zero crossing point.

This may not happen unless Timer 1 is locked to the mains. Without locking, the brightness counter could be anywhere between 225 and 275, depending on the mains frequency. (Over time, the average mains frequency is held very accurately at 50Hz but in the short term can drift a little).

We therefore lock the counter to the mains by adjusting Timer 1 in increments of 800ns either faster or slower over each 10ms period. Should the brightness counter alter from its 250 count at each zero crossing, Timer 1 is adjusted to compensate for the difference.

By remaining in lock, the lamp filament will produce a rock steady level even at very low brightness levels. Without the locking, the lamp could have a slight flicker under phase control.

The infrared signal is detected by IC2, an amplifier/demodulator. This converts the remote control's modulated 38kHz pulses into digital levels that can be read by the IR monitor. Decoding into digital levels occurs at the rate set by the Timer 2 which is also locked to the mains frequency.

If the mains frequency happened to drift too far off 50Hz, then the remote control decoding would not operate correctly and would result in loss of remote control operation. Fortunately, the mains frequency is well within 5% of 50Hz and with this variation the remote control will still operate the Automatic Lamp Dimmer.

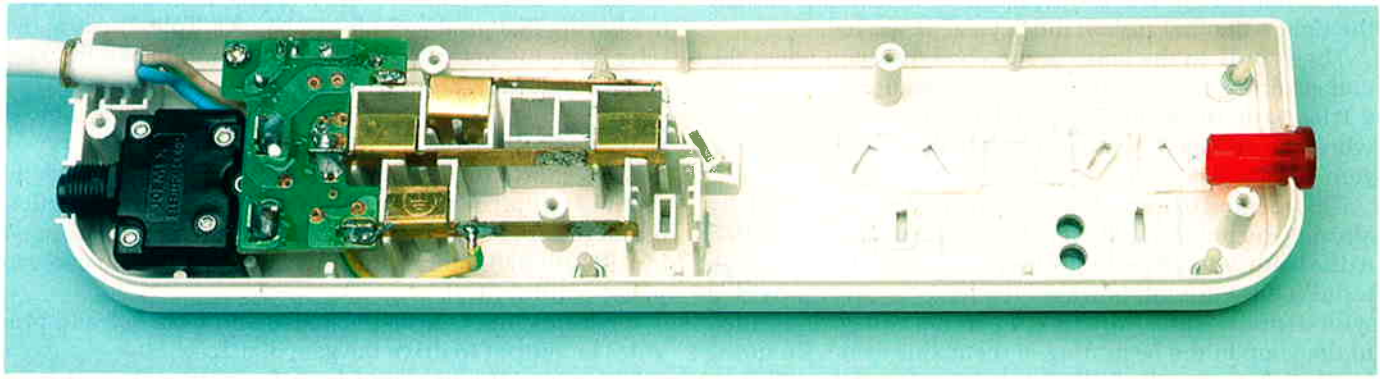
The IR monitor signal is compared with known codes in the decoding section. Input pins 11, 12 and 13 select the particular code that is used, with four different codes available. When the selected, stored code is the same as the received remote control code, the brightness register is altered in response to the particular button pressed on the remote control. For example, if slow down-dimming is selected, the brightness level register is increased to decrease lamp brightness.

The comparator monitors both the brightness level register and the brightness counter. When they are equal, the comparator provides a pulse to drive the Triac gate.

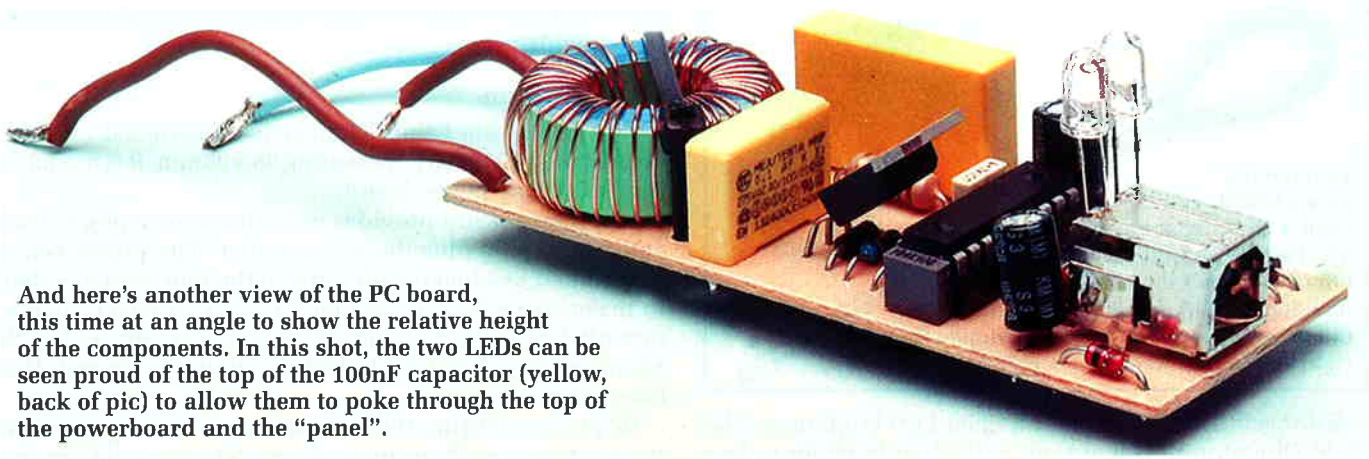
If the brightness level register is a low value, this value will be equal to the brightness counter early in the mains cycle to provide a bright lamp. If the brightness level register is a larger value, the value will be equal to the brightness counter later in the mains cycle and so the lamp will be dimmer.

The circuit

Considering the complexity of the Automatic Lamp Dimmer operation, there is not too much in the actual circuit itself. This is because the complexity is all taken care of within



The modified Powertech powerboard before the insertion of the PC board. Here we've cut away the bus bars, removed part of the plastic moulding and drilled the holes for the two LEDs and the infrared signal bezel (far right).



And here's another view of the PC board, this time at an angle to show the relative height of the components. In this shot, the two LEDs can be seen proud of the top of the 100nF capacitor (yellow, back of pic) to allow them to poke through the top of the powerboard and the "panel".

the microcontroller (IC1). Apart from this IC, there is only the infrared decoder (IC2), a Triac, several diodes, a crystal and an inductor, plus a few resistors and capacitors.

The Triac is connected between the mains Active and the lamp via an inductor (L1). This inductor, in conjunction with the 100nF 250VAC capacitor, provides suppression of electromagnetic radiation caused by the Triac switching. The inductor core is made from iron powder, which is lossy at high frequencies (above about 1MHz) and so prevents (or at least minimises) EMR from being radiated via the power wiring.

Power for the circuit is derived from the mains supply via a 220nF 250VAC mains capacitor and a 1kΩ 1W resistor. The capacitor and resistor act as a current limiting impedance for the following zener diode, ZD1.

The supply is derived in two steps. Firstly, supply is limited to 5V as diode D1 conducts when the mains voltage goes below the ground supply, pulling the anode of ZD1 to some 0.6V below the ground supply. This causes the zener to clamp the supply voltage to 5V (5.6V-0.6V).

Secondly, when the mains swings above the ground supply, current can flow through the forward-biased zener diode and into the 470µF supply decoupling capacitor to top up the supply.

Apart from the 470µF supply smoothing capacitor, both IC1 and IC2 have 100nF capacitors across their supply to provide high frequency decoupling. IC2 is further decoupled with a 100µF capacitor.

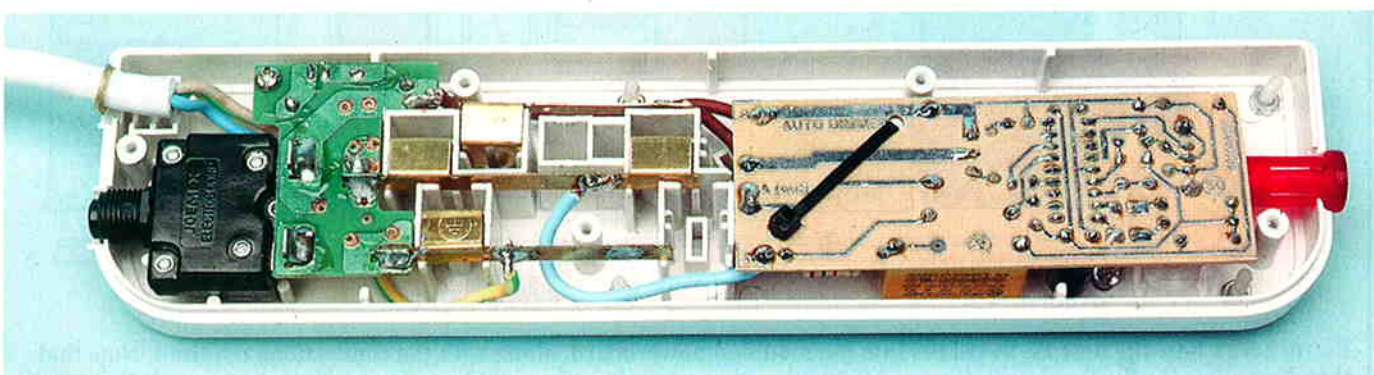
Power for IC1 is supplied between pins 14 and 5. Pin 4 is a brownout input – should the supply drop below about 4V, the IC will be held reset until the supply voltage rises above the 4V level. This brownout reset ensures the microcontroller will operate correctly after the brownout has ended.

Infrared code selection inputs are at the RB5, RB6 and RB7 pins. These pins can be left open or tied low with the linking to ground. When the microcontroller is reset after power is applied or after a brownout, the RB5, RB6 and RB7 inputs are pulled high via internal pull-ups within IC1. A check is made to determine whether the pins are all held high or if one is tied low via one of the links. This sets the remote control code that will operate the Automatic Lamp Dimmer. After this, the RB5, RB6 and RB7 input pull-up resistors are deselected and these inputs are set as low outputs.

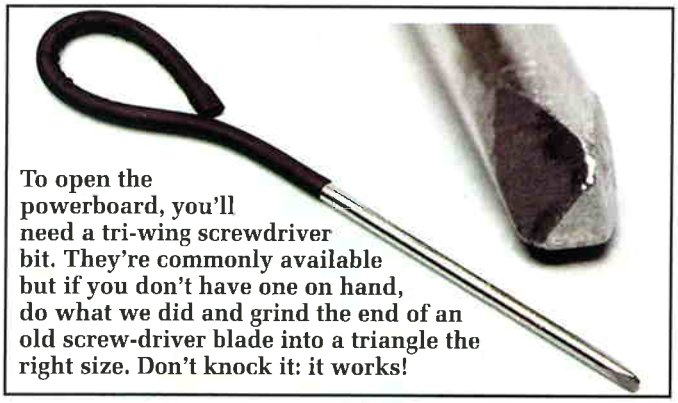
We need to set the RB5 – RB7 inputs as outputs to prevent them from floating and drawing excess current from the supply. The removal of the pull-up resistors from the inputs also removes the internal pull-up for RB0. This input detects the zero voltage crossing of the mains via a 1.5MΩ resistor and 4.7nF filter capacitor. The pull-up resistor is not required for the zero voltage detection since its value can vary from part to part, making the filter phase response too variable. This could produce an incorrect detection of the zero voltage crossing and causing faulty dimming characteristics such as flashing of the lamp.

IC1 outputs RB1, RB2 and RB3 drive the gate of Triac1 via a 39Ω resistor and fast diode D2. Gate current is limited to around 50mA because of the resistor. The diode prevents the 0.7V present on the gate when the Triac is switched on from feeding back into IC1.

Outputs RA1 and RA0 drive the "acknowledge" and "auto dim" LEDs respectively. The Acknowledge LED is driven with short bursts of high levels from RA1 and the 470Ω



Now the new PC board has been placed and connections made back to the bus bars as required. What is not obvious here is that those connections should not just rely on the soldered joint; the wires should be twisted around the bus bars first.



To open the powerboard, you'll need a tri-wing screwdriver bit. They're commonly available but if you don't have one on hand, do what we did and grind the end of an old screw-driver blade into a triangle the right size. Don't knock it: it works!

resistor sets the current for sufficient LED brightness. The Auto Dimming LED is driven with slightly wider pulses and so can be driven with a lower current using the 1kΩ resistor. It is important that there is not too much current drawn from the supply as this is limited by that which can be delivered via the 220nF capacitor and 1kΩ resistor connecting to the mains Neutral.

The 20MHz crystal X1 provides IC1 with an accurate clock signal for the timing requirements in the phase control driver and remote control functions. The 33pF capacitors provide the correct loading for the crystal to ensure reliable starting of the oscillator when power is applied.

IC2 receives and demodulates the codes from the infrared remote control. It incorporates an amplifier and automatic gain control plus a 38kHz bandpass filter to accept only remote control signals. Upon detection of an infrared signal, it detects and removes the 38kHz carrier. The resulting signal is applied to the RB4 input of IC1.

The high gain of IC2 makes it susceptible to interference from the switching of the Triac. The software has been planned so that the remote control signal is only monitored when interference is at a minimum. Interference does, however, affect the gain of IC2, which shuts down the gain as interference is detected due to its automatic gain feature. This gain reduction reduces infrared remote control range.

To help prevent this reduction in gain, IC2 is housed inside a shield to protect it as much as possible from external fields.

Construction

The Automatic Lamp Dimmer is constructed on a PC board coded 10107051, measuring 96 x 35mm. It is mounted inside a 4-way power board.

The power board provides us with a case, a power lead and mains plug plus the mains outlet. The power board is modified by blocking off three of the four mains outlets to make space for the dimmer circuitry. A cover plate is mounted over the blocked off sockets and secured with Nylon screws. Two LED indicators protrude through this cover plate.

Begin by checking the PC board against the published pattern to ensure there are no shorts between tracks or any breaks in the copper. Repair these if necessary.

First components to install are the resistors – use the colour code table as a guide to selecting each value and/or use a multimeter to check each value.

Solder in the socket for IC1, making sure the orientation is correct. Capacitors can also be inserted and soldered in place. The electrolytic types must be oriented with the polarity shown on the layout diagram, as must the diodes. Also ensure each is installed in its correct position. Install the Triac and crystal (the latter is not polarised).

IC2 is mounted in the position shown with the leads bent forward and then upwards so that the lens section of the device is still vertical and located about 5mm back from the edge of the PC board.

We made a shield for IC2 from a USB connector. Unclip and open up the rear of the USB socket's shield and slide out the internal part. Bend back the rear flap on the shield to its closed position and insert the shield in place over IC2 and solder the mounting tabs to the PC board. The rear flap of the shield may need to be soldered in position since the bending process will have weakened the metal where it was bent.

Inductor L1 is wound using 38 turns of 0.5mm enamelled copper wire, wound neatly, tightly and evenly around the core. This coil may produce a buzzing noise in the Auto-

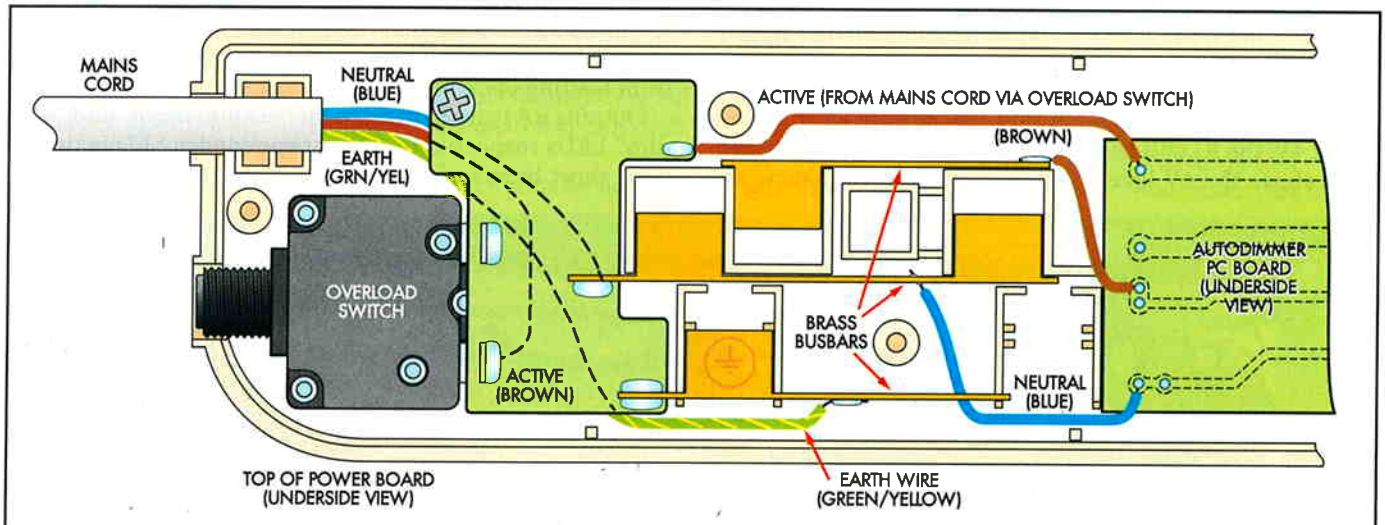


Fig. 6: here's how the new PC board fits into the modified powerboard, along with the connections required. Note that this diagram is for the Powertech (Jaycar MS4040) – other powerboards might be different. This diagram also gives you a good idea of where the busbars must be cut – a sharp pair of tinsnips is required here.

matic Lamp Dimmer, caused by the phase control method of dimming that produces sudden changes in current and movement in the wires.

To prevent this happening, you can coat the windings in some epoxy resin before installing the core on the PC board. When the resin is dry, insert the wires into the PC board holes where shown and secure the toroid in place with the cable tie. Strip off the wire insulation near the underside of the PC board using a sharp hobby knife and solder the wires in place.

Note that if you are using red-coloured enamelled wire, the insulation can be stripped with a hot soldering iron. Brass-coloured enamel will not strip under soldering iron heat and will need to be scraped off.

LED1 and LED2 are mounted so that the top of each is 25mm above the top of the PC board. The longer lead of each LED is the anode. The tops should not protrude through the panel when assembled but be level with its surface.

Leave the remote control code linking options for LK1 to LK3 open for the present.

Modifying the powerboard

We used a Powertech 4-way powerboard (from Jaycar Electronics) to house the project. Other powerboards may not have the same clearances nor setup inside.

The powerboard requires modification in order for the PC board to fit inside. Firstly, you will need to open it up – most (as ours did) use tamper-resistant screws to stop you doing just that!

The specified powerboard uses tri-wing screws, requiring a tri-wing screwdriver bit to open them. We didn't have one so we used a bench grinder to grind an old screwdriver blade down to a triangular shape, then bent it over to make a handle. It's rough . . . but it worked!

Inside the power board you will see that there are brass bus bars to carry the Active, Neutral and Earth connections. The three far end sockets (those further away from the mains inlet cord) need to be cleared to make room for the PC board. This is done by cutting back the bus bars so that they are available for the first mains socket but not for the final three.

Also, the plastic moulding will need to be removed to make space for the PC board components. This plastic can be removed with a small flat nosed set of pliers by twisting and breaking the plastic out from the case.

The infrared receiver bezel is actually the front part of a red plastic neon bezel. Clip the power board casings together and drill out the hole in the end of the case to suit the bezel – it should be small enough so that the bezel is held in securely when the power board is screwed together. Use some Super Glue to secure the bezel to one half of the casing if it can be prised out of its hole. Two holes will be required for the LEDs in the top of the case.

The powerboard we used for this project was a Powertech (Jaycar) MS4040. The PC board is designed to fit this one.

Parts List – Automatic Lamp Dimmer

1 PC board, code 10107051, 96 x 35mm
1 4-way mains power board (Powertech [Jaycar] MS4040 used in prototype)
1 pre-programmed "universal" infrared remote control (with channel numbers, volume and channel up and down plus mute and operate buttons)
1 133 x 51 x 3mm Perspex sheet (to cover three mains sockets)
1 powdered iron toroidal core, 28 x 14 x 11mm
1 B-type USB PC-mount socket (for the metal shield only)
1 20MHz crystal (X1)
4 M3 x 10mm Nylon screws
4 M3 nuts
1 all-plastic 240V red Neon Bezel (eg, Jaycar SI-2630)
1 1.6m length of 0.5mm enamelled copper wire
1 150mm length of brown 10A mains wire
1 100mm length of blue 10A mains wire
1 200mm long cable tie

Semiconductors
1 PIC16F628A microcontroller programmed with autolamp.hex (IC1)
1 BT137F 600V 8A Triac (Triac1)
1 infrared receiver decoder (IC2)
1 5.6V 1W zener diode (ZD1)
1 1N4004 1A 400V diode (D1)
1 FR102 fast diode (D2)
2 5mm high-intensity red LEDs (LED1,LED2)

Capacitors
1 470µF 16V electrolytic
1 100µF 16V electrolytic
1 220nF 250VAC X2 polyester
1 100nF 250VAC X2 polyester
2 100nF MKT polyester
1 4.7nF MKT polyester
2 33pF ceramic

Resistors (0.25W 1%)

1 1.5MΩ 1W 5%	1 2.2kΩ	1 1kΩ 1W 5%
1 1kΩ	1 470Ω	1 39Ω

The cover plate is essential – it stops the unwary (or unknowing) trying to use the powerboard as a powerboard and possibly damaging components inside. Make up the cover plate to suit the powerboard you are modifying (use the photos as a guide) – it covers three of the four mains sockets. The two LED holes are also drilled into this plate.

The plate is secured with Nylon screws, necessary as they provide insulation from the mains voltages inside the powerboard. We also recommend melting the Nylon screw ends over the nuts once installed to prevent them from becoming unscrewed. A hot soldering iron will do this.

On the particular power board we used, there are two slotted holes at the rear, designed to allow the powerboard to be secured to a wall using screws. We recommend that

Resistor Colour Codes				
	No.	Value	4-band Code (1%)	5-band Code (1%)
☐	1	1.5MΩ	brown green green gold (5%)	
☐	1	2.2kΩ	red red red brown	red red black brown brown
☐	1	1kΩ	brown black red gold (5%)	
☐	1	1kΩ	brown black red brown	brown black black brown brown
☐	1	470Ω	yellow violet red brown	yellow violet black black brown
☐	1	39Ω	orange white black brown	orange white black gold brown

Capacitor Codes			
Value	µF	IEC Code	EIA Code
220nF	0.22µF	220nF	224
100nF	0.1µF	100nF	104
4.7nF	.0047µF	4n7	472
33pF	NA	33p	33

you fill the hole that is located beneath the dimmer PC board with some Silicone sealant. This is because there is a possibility (admittedly remote) that some thin metal object could be poked through the hole onto back of the PC, with possible dire consequences.

Better to be safe than sorry, as mum used to say!

The Active bus bar will need to be disconnected from the main active supply lead so that the dimmer circuitry can intercept the Active before the mains outlet. The Earth lead connection may need to be relocated nearer to the mains socket. Make sure the wire is well soldered to the earth bus bar – it's always best to make a mechanical joint (ie, wrap the wire around the bus bar) which can hold by itself, then solder in place.

Wire up as shown and cut the neon bezel so that its length will just reach the metal shield for IC2 when installed into the case. The project is now electrically complete but before you reassemble the power board, give it a thorough visual check.

When you're satisfied everything is as it should be, screw the two halves of the power board together with the tri-wing screws.

Don't be tempted to work on the next part of the project, testing, before assembling the powerboard. Live wiring is dangerous.

Testing

Before testing, you will need to set the remote control to the appropriate coding. It is most unlikely that you will find any "universal" remote control which cannot be used with this project.

For the remote control we used, the "Big Shot 3 in 1" remote, the process is to press the SET and TV buttons together and then enter the numbers 191. For other remote controls, the process may be slightly different. The 191 coding is that for a Philips TV set. If you are using a different remote control, try the codes listed for Philips brand TV sets.

Plug a 40W (or more) 240V lamp into the power board socket and plug the powerboard plug into a mains power socket.

Check that the dimming can be set with the channel up and down buttons and that slow dimming works. The Mute button should switch the lamp on and off. Check that the automatic dimming works by pressing the appropriate button. If it does not work, check that the correct code has been entered into the remote. Observe operation of the LEDs during these tests.

If the remote control also activates other items that are located in the same room where you will be using the Automatic Dimmer, then the remote control coding will need changing.

The coding is changed by selecting one of the optional codes such as VCR1, SAT1 or SAT2. Generally, the SAT2 selection is a good choice. This is selected by soldering a bridge for link 3 on the dimmer PC board. Before doing this make sure (twice!) that the powerboard is unplugged from the mains so that it is safe to open.

The hand-held remote will need to be programmed for the code selection. To select SAT2, press SET and SAT together and then enter the numbers 425. This number may be different for another type of remote control unit. If selecting SAT1 use the numbers 424 and for VCR1, use 336. Also the linking on the dimmer PC board will need to be changed.

Note that for the VCR1 selection, the on and off function using the Mute button will not operate the Automatic Lamp Dimmer. Instead it will operate the mute in a TV set that works with the TV1 selection on the remote.

This feature is called punch-through, where selections that do not have a mute feature are operated by the TV code. **SC**

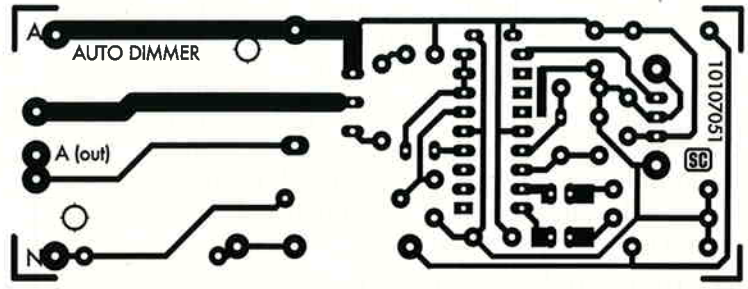


Fig. 8: the full-size PC board pattern – use this to check the etching and drilling of commercial boards, or use it to photographically etch your own PC board.

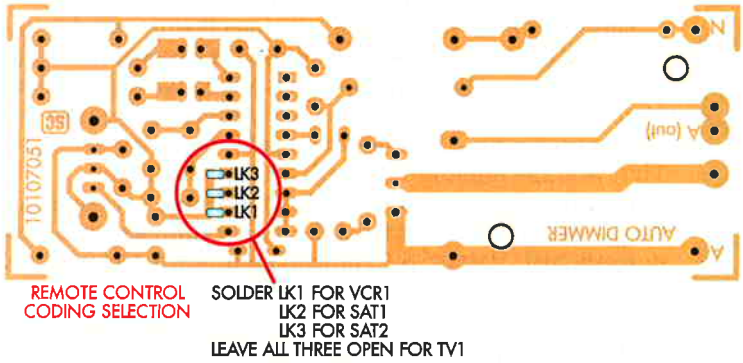


Fig.7: this view of the copper side of the PC board shows the three links which set the correct infrared decoding (see text).

Salvage It!

BY JULIAN EDGAR

Salvaging & using common thermostats

Thermostats are attached to or buried in lots of consumer items and are easy to salvage. Here's a look at the common types and some hints on how they're used.

NEED TO CONTROL A FAN, heater or pump on the basis of temperature? It's a common requirement that can be achieved using an electronic circuit with a thermocouple or thermistor input.

However, it's much cheaper and easier to use a thermostat salvaged from a junked consumer item. Whether you need to switch at room temperature or 200°C, the thermostat doesn't have to cost you a cent.

How they work

A thermostat is basically an adjustable temperature switch. Nearly all thermostats that you can salvage work in a similar way.

A special piece of metal – called a bi-metallic strip – is the basis of the design. As its name suggests, this strip is actually two different metals joined together. These two metals have different expansion rates so as they are heated, one gets longer faster than the other. This causes the strip to bend.

When it has bent far enough (ie, it's hot enough!), it breaks the connection between two electrical contacts, turning off the circuit. The switching temperature is varied by using a threaded rod to vary the distance between the electrical contacts and the bimetallic strip.

As you can imagine, in this type of design the electrical contacts open and close very slowly. In certain applications, this could cause arcing, so many thermostat designs use a "snap action" approach, where a small leaf spring causes the contacts to quickly snap open or snap closed once the trip point has been reached.

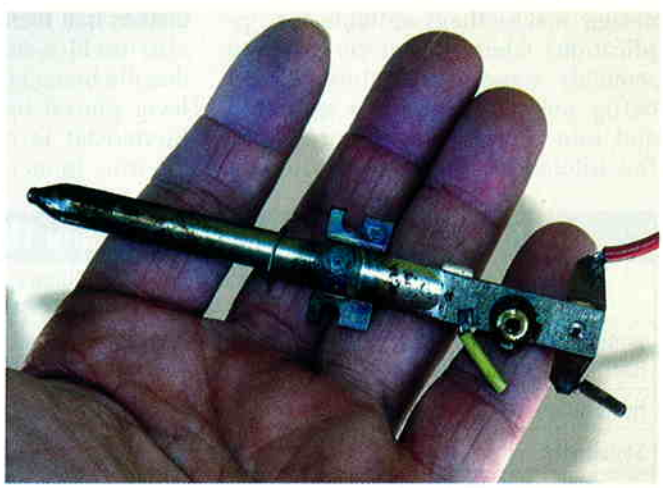
Another type of thermostat uses a remotely-mounted "bulb". This comprises a small copper cylinder (usually about as big as a short pencil) which is connected to the main switch mechanism by small-bore copper tube. The tube and the bulb are filled with a liquid or gas that expands as it gets warm and the resulting fluid pressure activates the switch.

Common consumer goods in which bimetallic strip thermostats are used include oil-filled electric space heaters, electric frypans and clothes irons. Remote bulb thermostats are used in old electric water bed heaters. Table 1 shows the characteristics of each of these types.

Selecting a thermostat

Scrounge a few of the abovementioned consumer items (eg, during a council clean-up) and in no time at all you'll have more thermostats than you know what to do with! So let's

You could pay lots for a professional looking thermostat like this... or instead use a salvaged frypan thermostat and a handful of other components to make your own for nearly nothing.



Electric frypan thermostats use a stainless steel probe that can be inserted through the wall of a pipe or into liquids. They can be adjusted to trip at temperatures from about 40-200°C.

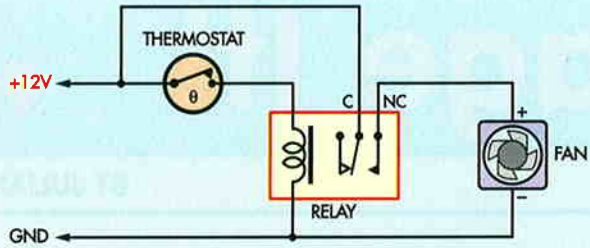


Fig.1: most thermostats are normally closed designs – ie, they open when the set-point temperature is reached. But by using a double throw relay, it's possible to turn on something when the thermostat opens, as shown here. This circuit shows how to switch on a 12V DC fan at temperatures above the thermostat set-point.

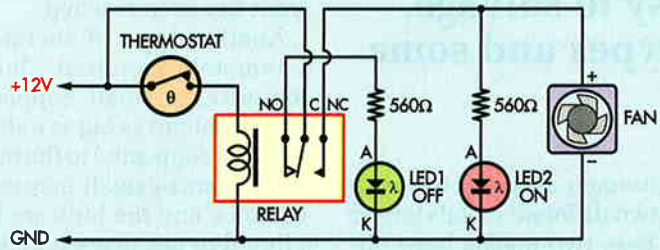


Fig.2: when a relay is used, adding LEDs to show the operating status of the thermostat is easy. In this case, LED1 lights when the fan is off, while LED2 lights when the fan is on.

take a look at the characteristics of each design.

Frypan thermostat: electric frypans (and electric woks) use a thermostat that's integrated into the module that plugs into the handle. The module has a knob on it (for setting the temperature) and a stainless steel probe, about the length of your little finger (but a bit smaller in diameter).

These thermostats can be set to operate from about 40-200°C. Their design makes them suitable for applications where the probe needs to remotely sense temperature; eg, by being pushed through a grommet and into a pipe. The hysteresis (ie, the difference between the switch-on and switch-off temperatures) is fairly small and they react quite quickly to temperature changes.

Both "snap-action" and "slow-moving" thermostats are used in frypans, with later models more likely to be the "snap-action" type. It's very easy to tell if you're salvaging a snap-action thermostat: hold the control box up to your ear as you slowly turn the knob. If you hear a satisfying "click", you know you're got a snap-action type.

Clothes iron thermostats: clothes irons also use bi-metallic thermostats. And despite being controlled by a knob or lever placed on top of the iron, the thermostat is mounted deep inside the iron. In fact, one end of the bimetallic strip is actually bolted to the aluminium baseplate.

These thermostats are "snap action" types and react more slowly than frypan thermostats (to ignore short-term temperature spikes). As a result, their hysteresis is also larger. Typically, they are suitable for sensing temperatures from about 60-200°C.

Because they don't use a remote probe, this type of thermostat is useful when the temperature of the general environment needs to be sensed.

Oil-filled heater thermostats: as with clothes iron thermostats, oil-filled heater thermostats are designed to sense the temperature of their environment and don't have a sensing probe. These thermostats are quite sensitive, have a small hysteresis and work at room temperatures, making them ideal for activating fans inside electrical equipment.

Water bed heater thermostats: these thermostats use a remote bulb, allowing temperature sensing at a point remote from the thermostat itself. They can be set very precisely over the 25-50°C range, are quite sensitive and have a small hysteresis. However, the bulb

Table 1: Characteristics Of Common Thermostats

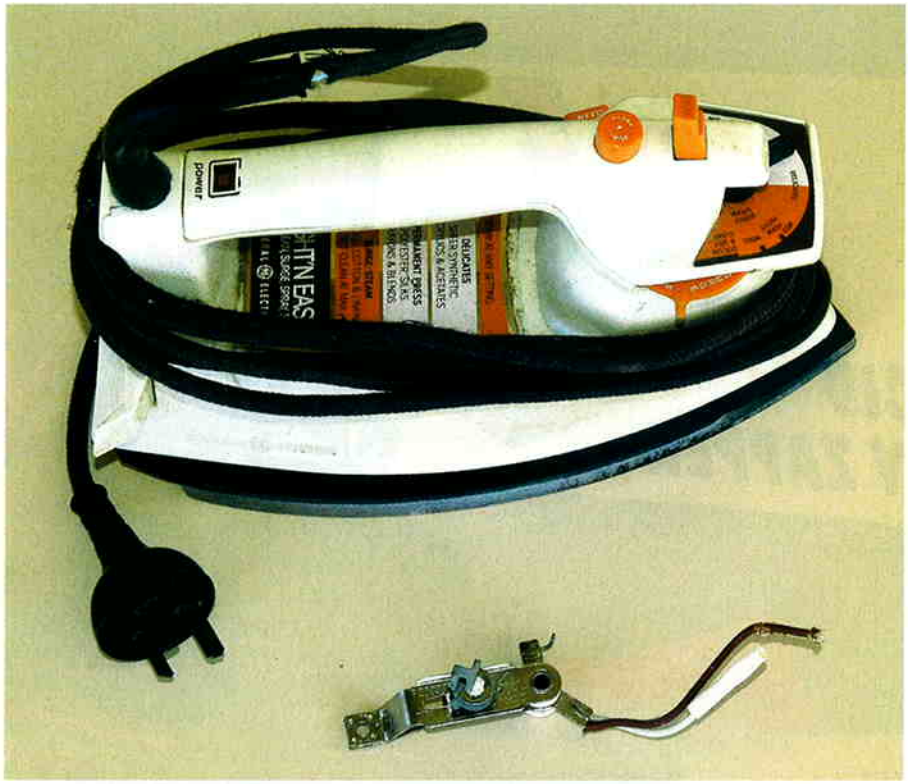
	Electric Frypan Thermostat	Clothes Iron Thermostat	Oil-Filled Heater Thermostat	Water Bed Thermostat
Temperature Range	Wide (40-200°C)	Fairly wide (60-200°C)	Narrow (5-50°C)	Narrow (25-50°C)
Hysteresis	Small	Large	Small	Small
Sensitivity	Medium	Low	High	High
Action	Many not snap action	Most snap action	All snap action	All snap action
Sensing	Short stainless steel probe	Whole thermostat	Whole thermostat	Remote copper bulb

Rat It Before You Chuck It!

Whenever you throw away an old TV (or VCR or washing machine or dishwasher or printer) do you always think that surely there must be some good salvageable components inside? Well, this column is for you! (And it's also for people without a lot of dough.) Each month we'll use bits and pieces sourced from discards, sometimes in mini-projects and other times as an ideas smorgasbord.

And you can contribute as well. If you have a use for specific parts which can easily be salvaged from goods commonly being thrown away, we'd love to hear from you. Perhaps you use the pressure switch from a washing machine to control a pump. Or maybe you salvage the high-quality bearings from VCR heads. Or perhaps you've found how the guts of a cassette player can be easily turned into a metal detector. (Well, we made the last one up but you get the idea . . .)

If you have some practical ideas, write in and tell us!



Every discarded electric iron has a thermostat mounted inside. These snap-action thermostats can be used to switch at temperatures from about 60-200°C.

may be too bulky for some applications and the sensing tube cannot be altered in length.

Using thermostats

Nearly all thermostats open when the trip-point is reached. This is because they were designed to control heating elements that need to be switched off when the temperature rises sufficiently. In other words, they're "normally closed" (NC) designs.

Take Care With Mains Voltages!

Although thermostats can be used to directly control mains voltages, we've covered only low-voltage DC switching in this article.

Make sure that you're up to speed with mains power wiring before attempting to use salvaged thermostats in high voltage applications. If you don't know what you're doing, the results could prove fatal!

Only the one pair of contacts is provided, so what do we do when want to turn something on (rather than off) when the trip-point is reached? This is easily achieved with a double-throw relay and Fig.1 shows how it's wired.

It's also easy to add a couple of LEDs to indicate the switching status of the thermostat. Fig.2 shows how to do this. In this case, LED1 lights when the fan is off (thermostat closed), while LED2 lights when the fan is running (thermostat open).

The two 560Ω resistors limit the current through each LED to about 18mA. **SC**

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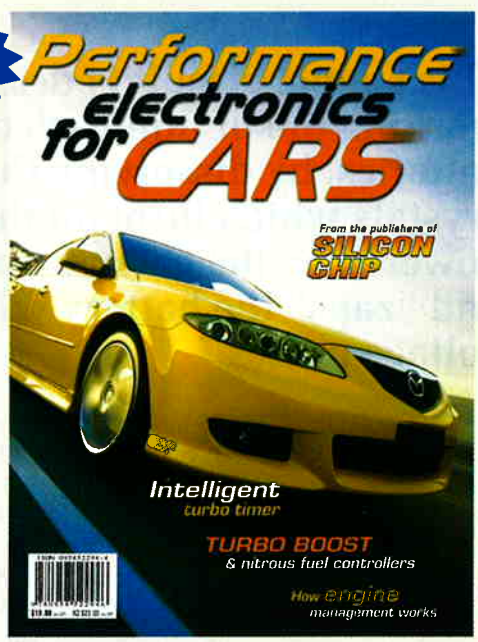
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Lead-acid Battery Zapper!

This simple circuit is designed to extend the working life of liquid-electrolyte lead-acid batteries, by dissolving the lead-sulphate crystals which form on their plates. It's powered by the battery itself (or by a charger) and "zaps" the battery with a series of high-voltage pulses.

LEAD-ACID BATTERIES have been around for over 170 years now – ever since Gaston Plante built the first one back in 1834. They are used in huge numbers all around the world, mainly in the automotive industry. There's at least one in virtually every car, truck and bus to start the engine and power ancillary equipment, while multiple lead-acid batteries are also used in many electric vehicles to provide the motive power.

They're also used in large numbers for energy storage in solar and wind power plants. And by the way, we're talking about "wet" or liquid electrolyte batteries here (also called "flooded" lead-acid batteries).

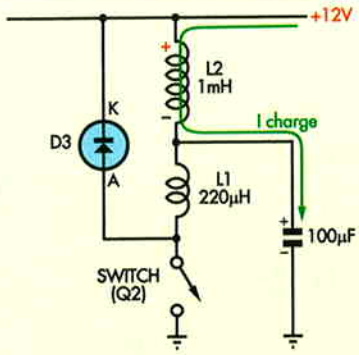
The lead-sulphate effect

Although we'd now be lost without them, lead-acid batteries are not without their faults. Probably their main drawback is that they have a relatively short working life, typically no more than about three or four years.

Why is this? Well, every time energy is drawn from a lead-acid battery, lead and sulphate ions from the electrolyte combine and are deposited on the plates in the form of soft lead-sulphate crystals. Then when the battery is recharged, these crystals dissolve again in the sulphuric acid electrolyte.

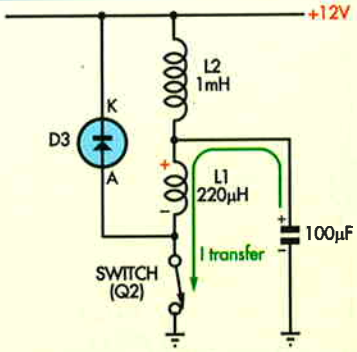
More accurately, MOST of them re-dissolve – but not all. Even if the battery is never over-discharged and is always recharged promptly after it has been discharged, a small proportion of the lead sulphate remains on the plates. These then harden into "hard" lead-sulphate crystals which are much less soluble and less conductive than before.

In practice, the formation of these



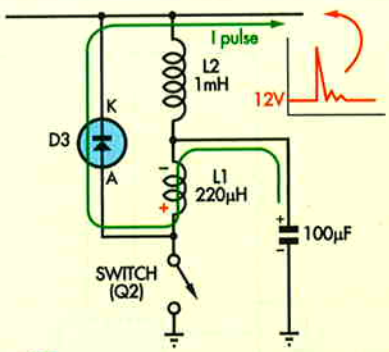
(A) CAPACITOR CHARGING PHASE

Fig.1(a): during the first phase of the circuit's operation, current flows from the battery (or charger) and charges a 100µF electrolytic capacitor via inductor L2.



(B) ENERGY TRANSFER PHASE

Fig.1(b): next, the switch is closed for 50µs, and current flows from the capacitor into L1. As a result, the energy stored in the capacitor is transferred to the inductor's magnetic field.



(C) DISCHARGE/PULSE PHASE

Fig.1(c): finally, the switch opens again, interrupting the inductor current and causing a high-voltage pulse across the inductor with the polarity shown. The green arrow shows the discharge current path.

hard lead-sulphate crystals gradually reduces the energy storage capacity of the battery. It does this both by masking the active areas on the plates and also by reducing the concentration of lead and sulphate ions in the electrolyte.

This "sulphation" effect has been understood for many years. It's also well known that the effect occurs much faster if a battery is over-discharged, left in a discharged state for more than a few hours, or frequently under charged. In fact, batteries mistreated in any of these ways tend to have a very short working life indeed.

For a long time, sulphation was regarded as non-reversible and batteries that had lost too much capacity due to this effect were simply discarded. This was not only wasteful but was also an environmental problem, because both lead and sulphuric acid are highly toxic materials.

Around the middle of last century, though, people in rural areas discovered that they could "resuscitate" sulphated batteries by zapping them with high-voltage pulses from their electric fence controllers. They didn't exactly understand why this method worked but kept using it because it did.

Subsequently, in 1976, the US Patent Office granted a patent to William H. Clark of Salt Lake City, Utah, for a method of charging lead-acid batteries by means of narrow high-current pulses. This was claimed to more effectively dissolve the lead sulphate crystals and hence prolong battery life. Since then a number of designs for pulse-type battery rejuvenators or "zappers" have appeared in electronics magazines, including one published in SILICON CHIP (Circuit Notebook) in February 2003 .

There is still a lot of argument about whether or not battery sulphation can be reversed and hence about the effectiveness of "zapper" type pulse rejuvenators. Our prototype did initially seem to achieve a useful amount of rejuvenation on a badly sulphated battery (which later went short circuit) but we really cannot vouch for the overall effectiveness of this circuit. It simply hasn't been tested on a wide enough range of batteries.

However, it's cheap enough to build, so interested readers can put one together and try it out for themselves.

By the way, please note that there is evidence that only "flooded" (liquid electrolyte) lead-acid batteries respond to this type of pulse desulphation. Sealed batteries with "gel" electrolyte don't respond much at all, so we don't recommend using the zapper on this type of battery.

It's also worth noting that even on flooded lead-acid batteries, pulse desulphation is not quick. It can take tens or even hundreds of hours to achieve a significant amount of rejuvenation.

A problem with many of the published zapper designs, including the one in our February 2003 issue, is that they use a P-channel power MOSFET. However, these are more expensive and harder to obtain than N-channel devices, so we've had quite a few requests for a new design using one of the latter devices instead. And that's exactly what we've done, with the design described here using a low-cost IRF540N MOSFET.

How it works

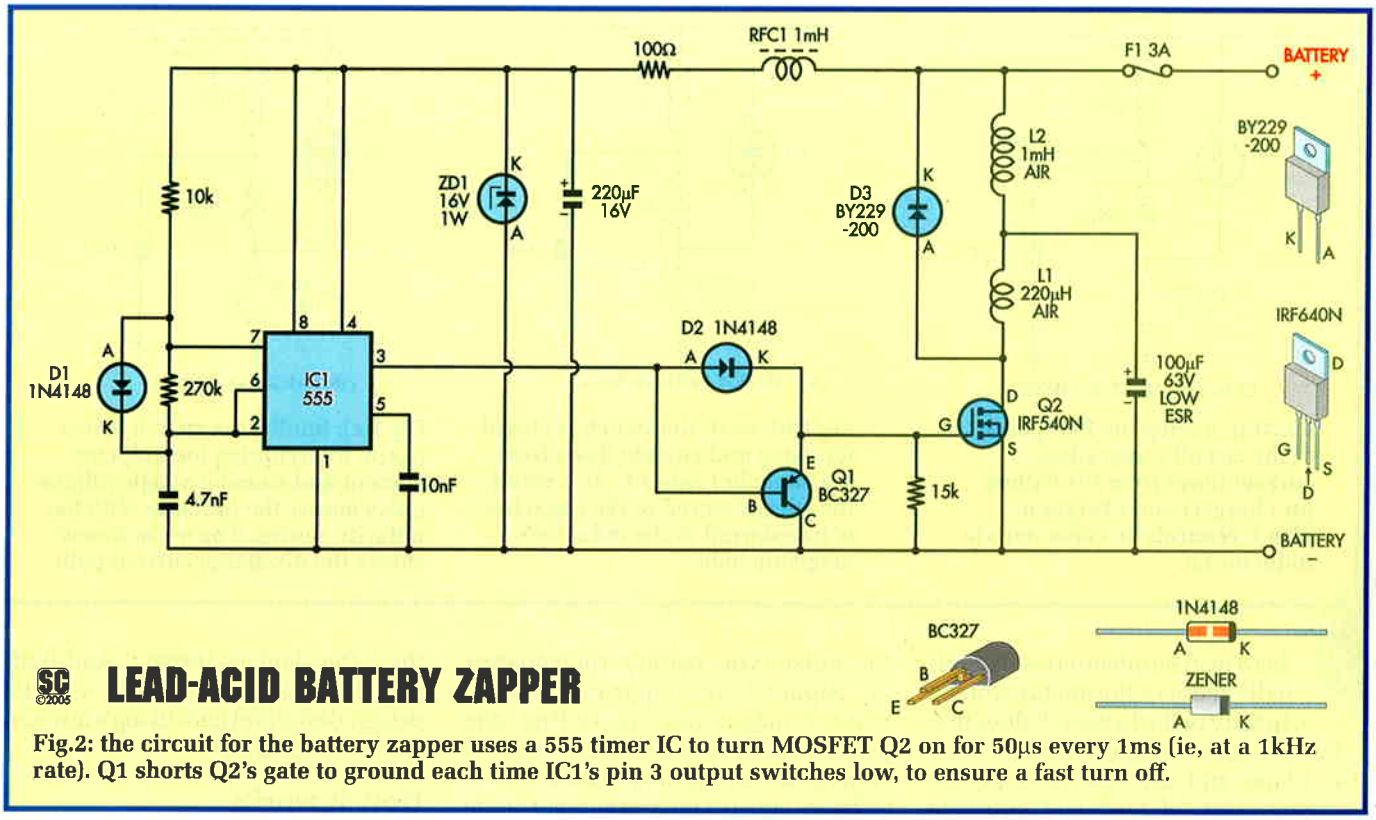
The basic principle used in desulphating zappers is quite simple: they draw a small amount of energy from either the battery itself or a charger connected to it, store this energy in a capacitor and then deliver it back to the battery as a narrow high-voltage pulse. In other words, a short pulse of current is forced through the battery

Disclaimer!

As stated in the article, our initial experiences with the Lead-Acid Battery Zapper indicated positive results. However, we must emphasise that our testing has been much too limited for us to make any claims or give any guarantees regarding the effectiveness of this unit.

In practice, you may find that the zapper successfully "rejuvenates" some batteries, particularly if the battery has simply sulphated due to lack of use. However, it cannot possibly rejuvenate a battery that is worn out – ie, one in which the active material on the plates has been severely degraded.

Depending on the battery, it's also possible that any rejuvenation effects may be only temporary in nature.



LEAD-ACID BATTERY ZAPPER

Fig.2: the circuit for the battery zapper uses a 555 timer IC to turn MOSFET Q2 on for 50µs every 1ms (ie, at a 1kHz rate). Q1 shorts Q2's gate to ground each time IC1's pin 3 output switches low, to ensure a fast turn off.

in the "charging" direction. It is these short current pulses which are claimed to dissolve the sulphate crystals (providing you're patient).

Fig.1 shows the basic scheme. As shown, the circuit consists of two small inductors, a 100µF electrolytic capacitor, a fast-recovery diode (D3) and a high speed electronic switch. The switch is actually the N-channel power MOSFET (Q2) but it's shown in Fig.1 as a switch because that's how it's being used.

During the first phase of the circuit's operation (A), current flows from the battery (or charger) and charges the 100µF electrolytic capacitor via 1mH inductor L2. This charging phase lasts about 950µs, which is quite long compared with the next phase.

Next, during the second phase of operation (B), the switch is closed. This connects 220µH inductor L1 to ground (battery negative), resulting in a sudden flow of current from the capacitor into L1. As a result, the energy stored in the capacitor is transferred to the inductor's magnetic field.

This phase only lasts for about 50µs – ie, just long enough for the energy transfer to take place.

At the end of the second phase, the switch is opened again (C). This sudden interruption of the inductor current causes an immediate reversal of the voltage across the inductor and so a high-voltage pulse appears across the inductor with the polarity shown. As a result, a discharge current pulse flows from the 100µF capacitor, down through L1, up through diode D3 and then out through the battery. This is the third phase of the circuit's operation.

This sequence of events is repeated indefinitely while ever the "zapper" is connected to a 12V battery (or battery and charger combination). That's because as soon as the discharge energy pulse from L1 has ended, the 100µF capacitor begins charging again via L2. So the remainder of the third phase becomes the first phase of the next charge-transfer-discharge cycle and that's how it keeps going.

This view shows the completed PC board. It's dominated by the 1mH and 220µH inductor coils.

Circuit details

Fig.2 shows the full circuit details of the Lead-Acid Battery Zapper. It incorporates all the circuitry shown in Fig.1, plus some extra parts to generate the short pulses to turn MOSFET Q2 on for 50µs every 1ms. In other words, Q2's gate is driven with

50µs-wide positive pulses at a rate of 1kHz, which means that the pulses are spaced 950µs apart.

This train of narrow pulses is generated by 555 timer IC1, which is connected as an astable oscillator. Diode D1, the 10kΩ and 270kΩ resistors, and the 4.7nF timing capacitor ensure a very high mark-space ratio at the pin 3 output. In operation, D1 ensures that the 4.7nF capacitor charges up very quickly via the 10kΩ resistor but can only discharge relatively slowly via the 270kΩ resistor (ie, when the internal discharge transistor on pin 7 turns on). As a result, IC1's pin 3 output goes high for 50µs, then low for 950µs and so on.

Transistor Q1 and diode D2 are used to ensure that the pulse stream from pin 3 of IC1 turns switch Q2 on and (especially) off very rapidly. In effect, they compensate for the charge stored in Q2's gate-channel capacitance when the MOSFET is turned on.

They do this very simply: when IC1's output goes high, D2 conducts and the pulse is applied directly to Q2's gate to turn it on. When IC1's output subsequently drops low again, this suddenly turns on transistor Q1 and effectively connects a short-circuit between Q2's gate and ground. As a result, the gate charge in Q2 is discharged very rapidly, making Q2 turn off again in very short order.

There's very little else left to explain.

The large inductors on this prototype unit were secured using spacers, screws and washers but the final version uses cable ties to secure the inductors instead.

Inductor RFC1, the 100Ω series resistor and zener diode ZD1 allow the +12V DC rail to be applied to IC1 but block the high-voltage pulses generated in the output stage from reaching the IC. Fuse F1 is there to protect the circuit from damage if the supply leads to the battery (or charger) are connected with reverse polarity.

Construction

Construction of the Lead-Acid Battery Zapper is straightforward, with all parts (except for the fuse) mounted on a PC board coded 14107051 and measuring 122 x 57mm. This board has cutouts in each corner so that it fits snugly inside a standard UB-3 utility box (130 x 67 x 44mm).

Fig.3 shows the assembly details. As usual, it's easiest to fit the low profile resistors and inductor RFC1 first, followed by the smaller capacitors and then the electrolytics. Note that the electrolytics are polarised, so make sure they go in the right way around.

Next, fit diodes D1 and D2, again taking care to ensure correct polarity. The same applies to zener diode ZD1, which can also now go in.

That done, fit transistor Q1, MOSFET Q2 and diode D3, which is in a 2-pin TO220-style package similar to the package for Q2. These devices are

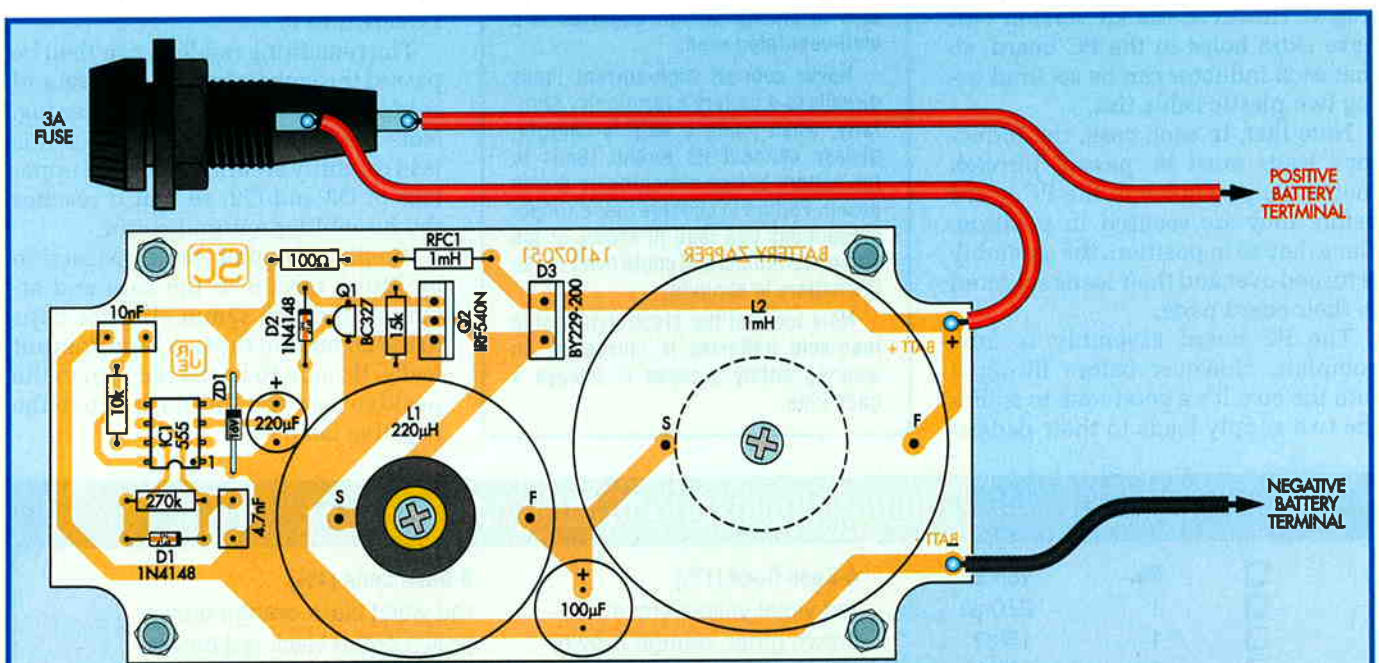


Fig.3: follow this parts layout diagram to build the PC board. Note that the PC board sold by Jaycar will have extra holes so that the large inductors can each be secured using two cable ties.

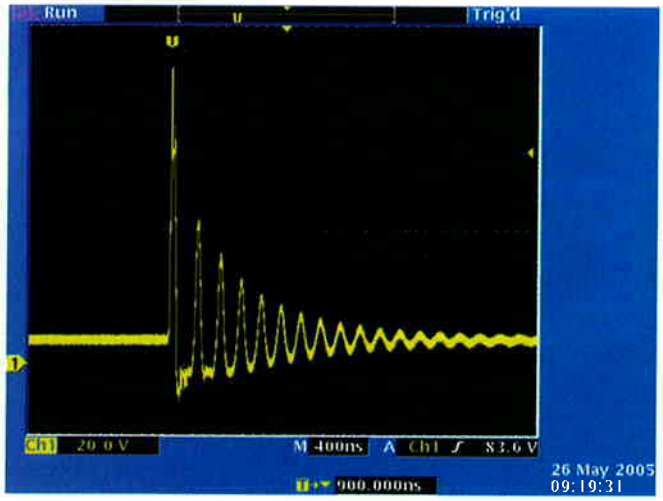


Fig.4: this scope shot shows the pulse waveform delivered to the battery. Note the ringing in the pulse waveform following the main 50µs spike.

all polarity sensitive, so again follow Fig.3 carefully to ensure correct orientation. Follow these parts with IC1, which should be fitted with its notched end towards the 270kΩ resistor.

The last components to fit are the two large air-cored inductors (L1 and L2). These are both wound on plastic bobbins, with their wire ends emerging from holes or slots in the lower cheek.

Securing the inductors

Both inductors on the prototype were secured to the board using nylon spacers inside their centre void, with a screw at each end, along with an M3 flat washer and 16mm grommet at the top of L1. This is the method shown in the photos and on the wiring diagram (Fig.3). However, the kit version will have extra holes in the PC board, so that each inductor can be secured using two plastic cable ties.

Note that, in each case, the inductor's leads must be passed through their matching holes in the PC board before they are secured in position. Once they're in position, the assembly is turned over and their leads soldered to their board pads.

The PC board assembly is now complete. However before fitting it into the box, it's a good idea to solder the two supply leads to their pads at the righthand end of the board. Just strip 4mm of insulation from the end of each length of cable, pass these down through their respective holes in the PC board (red to positive, black to negative) and solder them to the PC pads underneath.

Final assembly

The PC board assembly is supported inside the case on four M3 x 6mm untapped spacers and secured using M3 x 12mm countersink head screws, lockwashers and nuts.

The first step is to use the board itself as a template to mark out the mounting holes. That done, remove the board, drill the holes to 3mm, and use an oversize drill-bit to countersink the holes from the back of the case.

A further two holes are required at one end of the case to pass the battery leads and these can be drilled to 4mm about 10mm down from the top. The panel-mount fuseholder is mounted at the other end of the case and requires a shaped hole to suit the threaded body. This hole can initially be drilled to 4mm, then carefully enlarged using a tapered reamer and shaped using a small flat file.

That done, the board assembly can be fitted to the case. This is done by first installing the four screws and fitting the 6mm-long spacers, after which the board assembly can be lowered into position while feeding its negative (black) power lead out through its matching hole at one end. It's then simply a matter of fitting the lockwashers and nuts and tightening up the screws, to secure the assembly in place.

The next step is to cut the positive (red) input/output lead about 120mm from the end of the board and remove about 5mm of insulation from the free end. That done, fit the fuseholder to the lefthand end of the case, with its side solder lug uppermost for access, and solder the positive lead from the PC board to it.

The remaining red lead can then be passed through its hole in the case and soldered to the fuseholder's other lug. Note that you will have to dress this lead carefully around L2 and the upper tabs of D3 and Q2, so that it reaches the fuseholder without strain.

Finally, complete the construction by fitting the lid to the case and attaching the two 32mm alligator clips to the far ends of the two input/output leads. Be sure to fit the red clip to the positive lead and the black clip to the negative lead.

WARNING!

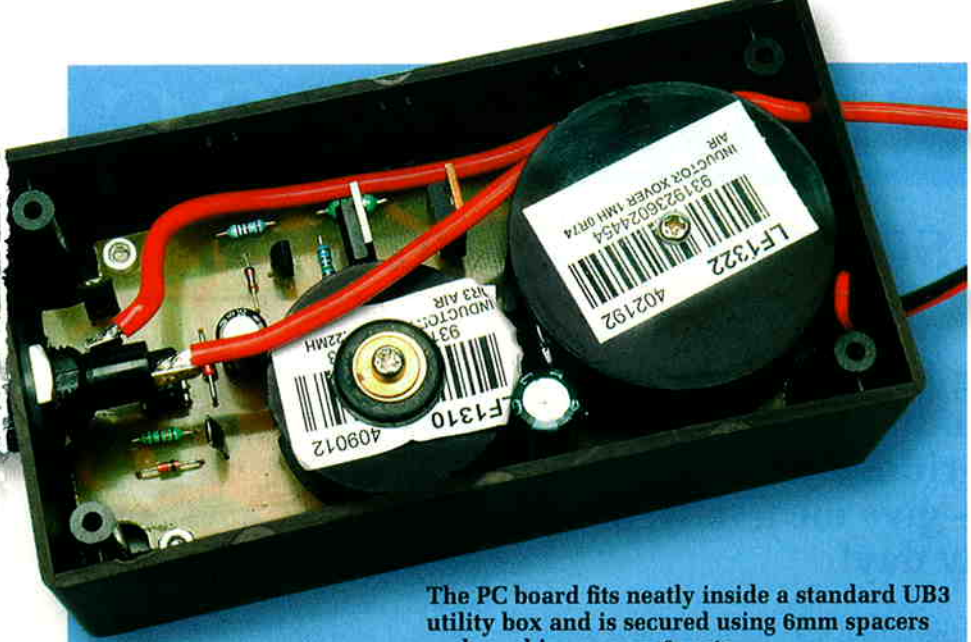
Hydrogen gas (which is explosive) is generated by lead-acid batteries during charging. For this reason, be sure to always charge batteries in a well-ventilated area.

Never connect high-current loads directly to a battery's terminals. Similarly, when using a battery charger, always connect its output leads to the battery before switching on mains power. Failure to observe these simple precautions can lead to arcing at the battery terminals and could even cause the battery to explode!

Note too that the electrolyte inside lead-acid batteries is corrosive, so wearing safety glasses is always a good idea.

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	270kΩ	red violet yellow brown	red violet black orange brown
❑	1	15kΩ	brown green orange brown	brown green black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	1	100Ω	brown black brown brown	brown black black black brown



The PC board fits neatly inside a standard UB3 utility box and is secured using 6mm spacers and machine screws & nuts.

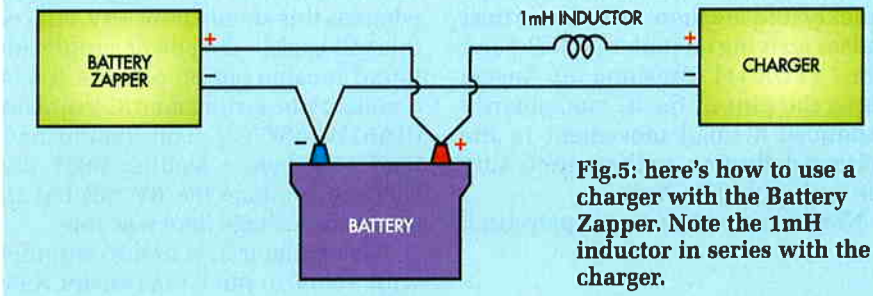


Fig.5: here's how to use a charger with the Battery Zapper. Note the 1mH inductor in series with the charger.

Your battery zapper is now complete and ready to use.

Putting it to use

Using the zapper is easy – just connect its leads to the terminals of the battery you want to rejuvenate (red to positive, black to negative).

There's only one qualification: if the battery is already so discharged that it can't supply the 50mA or so needed to operate the zapper, you'll need to connect a conventional trickle (or low-current) charger to the battery as well – at least to get the rejuvenation process started (see Fig.5). And if the battery is very badly sulphated as well, you'll have to keep the charger connected for quite a while.

After that, it's simply a matter of leaving it to pulse away until the sulphate crystals inside the battery have dissolved. This can take quite some time – from a few days to a few weeks – so you need to be patient.

If your charger doesn't have an inbuilt current meter, you can connect an ammeter in series with one of its leads so that you can monitor the charging rate. This should increase slowly as the sulphate crystals dissolve.

By the way, if you do have to connect a charger to the battery to power the zapper, you *must* use a 1mH air-cored inductor (the same as L2) in series with one of the charger's leads – see Fig.5. There are two reasons for this:

(1) to protect the output circuitry of the charger from possible damage; and

(2) to prevent the charger's relatively low output impedance from shunting the pulses, thereby reducing their effectiveness.

It doesn't always work

A final warning: not all lead-acid batteries are capable of being desulphated by using this zapper (or anything else, probably). In some batteries, the lead-sulphate crystals stubbornly resist the pulsing effect and the battery can sometimes even develop a short-circuit between the plates.

So if the battery charger current suddenly increases to a very high level, remove the power and write that battery off as one that cannot be saved. In other words, there are no guarantees that the zapper can resurrect *all* badly sulphated batteries – it can't. But, on the other hand, it's easy and cheap to build, so there's not much to lose in giving it a try. **SC**

Parts List

1 PC board, code 14107051, 122 x 57mm
1 utility box, UB3 size (130 x 67 x 44mm)
4 6mm long untapped metal spacers
4 12mm long M3 machine screws, countersink head
4 M3 nuts and star lockwashers
1 220µH air-cored crossover inductor (L1)
1 1mH air-cored crossover inductor (L2)
1 1mH RF choke (RFC1)
4 plastic cable ties (to secure inductors L1 & L2)
1 M205 panel-mount fuseholder
1 3A slow-blow M205 fuse
1 1.5-metre length of heavy-duty cable, red insulation
1 1-metre length of heavy-duty cable, black insulation
1 pair of 32mm alligator clips (red & black)

Semiconductors

1 555 timer (IC1)
1 BC327 PNP transistor (Q1)
1 IRF540N N-channel 60V/12A MOSFET (Q2)
1 16V 1W zener diode (ZD1)
2 1N4148 diodes (D1,D2)
1 BY229-200 fast recovery diode (D3)

Capacitors

1 220µF 16V RB electrolytic
1 100µF 63V low-ESR RB electrolytic
1 10nF greencap
1 4.7nF greencap

Resistors (0.25W 1%)

1 270kΩ
1 15kΩ
1 10kΩ
1 100Ω

Where To Buy A Kit

This project has been sponsored by Jaycar Electronics and they own the design copyright. A kit of parts is available from Jaycar for $A39.95 – Cat. KC-5414.

SERVICEMAN'S LOG

Computer servicing: a hard slog

There's no money fixing VCRs any more so I reluctantly take on the odd computer to keep busy. But fixing a virus-ridden computer is really never much fun – give me a telly with an intermittent fault any day!

Mr Bronwyn needed some help getting his 2001 JVC AV29LS (CH chassis) out of the car. That's because this particular JVC model is a bulky and heavy flat screen job, while his sedan was small and elderly to boot – rather like himself. Nevertheless, we managed.

He complained that his set had no picture, just a white line across the screen. In this case, however, the white line was across the bottom of the screen and not the centre, which was rather unusual.

I started with the vertical output IC (IC41, LA78041) and the oscilloscope quickly told me there were no vertical pulses arriving on pins 1 (VDRB-) and pin 7 (VDRA+). Brushing my fingers along the pins of the IC momentarily produced a small movement in the vertical deflection, so I was pretty sure the fault didn't lie here.

Next, I traced the signal path back to pins 21 & 22 of the microcontroller/jungle IC (IC701) but there was still no signal. This indicated that IC701 itself was the likely culprit. The only trouble was that this 64-pin device (TAD9365NI3S0572) costs $123.30 trade plus freight, so before removing it, I decided to check the DC voltages on it to confirm my diagnosis.

First, I measured +3.3V on pins 54 & 56 of the microcontroller section, which is correct, but I found only +5V on pin 14 of the jungle section, whereas this should be at +8V. I traced this rail back to the power supply and found it came out on pin 1 of IC974, a composite switchable IC regulator (BA51W12ST-V5). This should have read +9V before feeding R957 and D955 to produce the 8V rail but instead, the voltage here was low.

The regulator IC is in turn supplied with +9.6V to pin 2 via resistor R969 (2.7Ω) and this voltage was also low. However, the other side of the resistor was at +13V!

A quick check confirmed that resistor R969 had gone high. And as might be expected, replacing it brought all the voltages up to normal and restored the vertical deflection.

Of course, all this was relatively easy compared to trying to stuff the telly back into Mr Bronwyn's car!

ROCKS
PEBBLES
I THINK I MUST HAVE ROCKS IN MY HEAD~BUT I REALLY DO NEED THE MONEY
CHOO!
THE STRAITENED, IMPECUNIOUSLY INDIGENT & BROKE SERVICEMAN
PLEASE ENTER GENEROUSLY & OFTEN

Sony TVs

I have seen a lot of Sony TVs over the years, due to this popular brand being one of the market leaders. One thing that has intrigued me is observing how the G3E chassis has evolved

Items Covered This Month

- JVC AV29LS TV set (CH chassis)
- Sony KV218SAS TV set (G3E chassis)
- Various computer repairs
- Blaupunkt FM310.32 / Grundig CUC5360 TV set

BEFORE I RETURNED THE REPAIRED SET TO HIM, I DECIDED TO TAKE A FEW EXTRA PRECAUTIONS...

into the BG1S, then the BG2S and onto the BG3S series. At first glance, these chassis all look identical but they are not interchangeable and vary with the options a particular model offers – which number about 20 over the last 10 years.

Most of the faults in these chassis are well-known now but occasionally a new one is found as the components age. For example, the horizontal output transistor can fail due to dry joints on the horizontal output transformer. However, probably the most common fault is failure of the sky-blue ceramic capacitor (C820) between the collector emitter of the line output transistor. Just replacing it fixes the dead symptom, fortunately.

I've also found that the flyback transformer can fail, taking out the horizontal output transistor with it. However, this doesn't happen all that often.

Recently, I had an interesting case with an older G3E chassis. The set was a KV2185AS and the 2SD1878CA line output transistor (Q802) had gone short circuit, taking the 800mA IC fuse (PS801) with it.

Unfortunately, replacing these parts didn't fix the set. At switch-on, it would try to start up, with a rush of EHT static and the red LED coming on. But that's as far as it would go, the set then switching off again within a few seconds.

A quick check showed that the main +115V rail was steady and almost everything I measured was perfect. It took a very long time to finally work out with the oscilloscope that the drive to the line driver transistor (Q801) was faulty. This, in turn, was due to a dried-out capacitor (C513, 1µF) in the line feeding the horizontal pulses from pin 27 of the jungle IC (IC301, CXA1213BS) and it had undoubtedly killed the previous horizontal output transistor as well.

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I RELUCTANTLY TAKE ON THE ODD COMPUTER TO KEEP BUSY...

Replacing this capacitor restored everything to normal.

Computer woes

I have been having fun and games with computers recently.

First, I needed a new hard drive for my own computer and was offered a 120Gb Western Digital at a very cheap price. And having bought it, I couldn't wait to get it home and install it.

Now, not being that flush with money, my computer is a few years old and is only a Pentium 4 1.8GHz with IDE drives. I was therefore very surprised when I got the Caviar WD1200JD–00HB0 out of its anti-static bag and found that it was fitted with connectors I had never seen before.

Well, of course, most of you will recognise that this model is a serial ATA (or SATA) drive – as opposed to parallel ATA (PATA) drives which are now on the way out. SATA drives have been steadily growing in popularity over the last few years and have all sorts of features to make them faster.

However, this wasn't of much immediate use to me because my Gigabyte GA8VT800-RZ motherboard has IDE sockets only and doesn't support SATA drives. On the other hand, I didn't want to take the drive back as it really was a bargain, so I decided to see if there was a way around the problem.

To cut a long story short, I got onto the Internet and discovered that you can buy at least three different types of EIDE/SATA adaptors or, as the trade likes to call them, PATA/SATA converters. One lets older IDE drives work with modern SATA-socketed motherboards, one lets you use SATA drives with IDE motherboards (like mine) and the third is a SATA controller card (it plugs into a PCI slot on the motherboard).

Well, naturally I went back to my supplier, all eager to get the right one for my motherboard, only to find that he didn't have one. What's more, at least six other computer stores in my general area didn't stock them either. In fact, some had never heard of such devices and one even tried to flog me a new motherboard!

After some further searching, I eventually found a store that could help and bought a VScom dual-port SATA-150 PCI controller card. This card also supports RAID (Redundant Array of Independent Discs) mirroring or striping, although I had no plans to use this feature.

The installation is quite straightforward – just plug the card into a spare PCI slot, install the red SATA data cable and connect power to the drive. That done, I copied the XP drivers off the supplied CD onto a floppy disk so that they could subsequently be installed during the Windows XP installation.

In the end, it all worked fine except for one annoyance – when you switch on the computer, it says it cannot "see" the hard drive and invites you to press F1 to continue. Once you press F1, it then it boots up normally.

This turned out to be a BIOS issue with this particular computer. When I later tested SATA card with another board, it booted straight up, without any need to press F1.

Because of this, I decided to try an IDE-to-Serial ATA 150 converter. Unfortunately, this wasn't a success because the machine kept crashing during boot-up, even in Safe Mode. I can only assume that this was because I had already installed Windows XP using the PCI controller.

My guess is that the only way to use the adapter is to install XP from scratch using this set-up.

RAM problems

My next hardware upgrade also ran into problems. I purchased three 512Mb PC3200 DDR memory SIMMs but found that no matter what combination I tried, the computer would only recognise 1Gb of RAM – ie, only two out of the three SIMMs was being recognised.

My first attempt to solve this was to download and install the latest BIOS update for my motherboard but still it wouldn't recognise the third SIMM. According to the manual, the Gigabyte motherboard can recognise up to 3Gb in RAM, so I can only assume that there is something wrong with my particular board. It might even be one of the RAM sockets that's faulty but I haven't tested this theory.

An infected computer

My next computer job involved dealing with a customer's computer

that had been infected with a very nasty virus. I sometimes think I must have rocks in my head to take some of these jobs on but I really do need the money.

The machine in question was an old HP Pavilion 722a (P8571A) that had been hooked up unprotected to the internet. It was now suffering from a number of problems – many programs would no longer run, it was very slow and it had a lot of porn on it. And to add insult to injury, it was throwing up a rude message that was totally inconsistent with the character of its owner.

Every time I tried deleting the porn files, they would be re-written immediately. The machine was running an old version of Norton AntiVirus but the subscription had well and truly expired (by several years) so I couldn't run Live Update. What's more, the virus prevented the program from being un-installed and so I couldn't install an up-to-date version which the customer had purchased.

Clearly, the first job was to identify and eliminate the virus. I tried downloading and installing programs like Stinger, Spybot Search and Destroy, Ad-Aware and RegClean but more often that not, the programs just would not run. In the end, I took the hard drive out and fitted it as a slave on another computer with Norton Antivirus 2005, which was up to date. This soon identified and killed the virus which was a worm called W32.Serflog A.

That done, I refitted the drive back into the old HP and found that full control had been restored. It was then just a matter of cleaning up any spyware (using Ad-Aware and Spybot Search and Destroy), getting rid of a mass of temporary (.tmp) files and defragging the drive.

But why do people leave their computers wide open like this? If you connect to the internet, you absolutely must have a firewall and an up-to-date anti-virus package – no "ifs" or "buts". You must also promptly install any critical security patches for the operating system (preferably automatically if you have a broadband connection) and you must regularly sweep the machine for spyware.

Sock it to me

Another customer brought in his computer which was running Windows XP Pro. Its problem was that it could dial-up and connect to the internet successfully but Internet Explorer could not navigate to any websites, including Windows Updates. Similarly, Outlook Express was unable to send or receive any email.

I ran RegClean through it and checked for viruses but nothing turned up. I then tried upgrading the XP Pro operating system to Service Pack 2 (SP2) but the problem persisted.

The only clue I had was an error message that said "a socket could not be created" and "Host not found". This indicated a Windows socket (or winsock) error, probably due to a corrupted Winsock2 key in the registry. This can be caused by the installation of Spyware or by the incorrect installation of networking software.

In Windows 98 and Windows Me, the cure was to first edit (regedit) the registry and delete the Winsock2 key from Hkey_Local_Machine\System\CurrentControlSet\Services. That done, the Winsock2 key was rebuilt by removing the Dial-up Networking feature from Windows Setup (via Add/Remove Programs in Control Panel), then immediately reinstalling it again

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and rebooting the machine.

Windows XP with SP2 handles things rather differently and includes tools that let you both test the Winsock2 key and repair it if it is damaged. This is all described in Microsoft Knowledgebase Article 811259: "How To Determine And Recover From Winsock2 Corruption".

This approach is necessary because the TCP/IP stack is a core component of the XP operating and cannot be removed. It can, however, be reinstalled over the top of the original (after deleting the Winsock and Winsock2 keys from the registry). However, provided you're using SP2, there's an even easier way to go about this.

First, you can determine whether the Winsock2 key is corrupted using the Netdiag tool. Note that this tool is not installed with XP by default. However, it's quite easy to install it (and other "Support Tools") from the Windows XP Setup CD, as described in Article 811259.

Alternatively, if you don't have the setup CD handy, you can run Msinfo32. Again, the details are set out in the Microsoft article.

If the Winsock2 key is corrupted and you have SP2 installed, it can be repaired using the *netsh* command – you just type *netsh winsock reset* at the command prompt and press Enter. You then reboot the computer, after which you can also use the *netsh* command to rebuild the Winsock key (see Article 811259 for details).

Note, however, that some anti-virus, firewall or proxy clients may no longer work properly after you run the *netsh winsock reset* command. According to Microsoft, it's simply a matter of reinstalling any affected programs to fix this. You have been warned – don't go playing with the *netsh* command unless you really do have Winsock2 problems and know what you are doing.

If all else fails, you can download a utility called *WinSockXPFix.exe* (just Google for it). This fixed the Winsock problems on this particular computer and it was able to once again browse the internet and send and receive email. In this case, the Winsock "catalog" must have been corrupted before SP2 was installed, so the self-healing *netsh* command had no effect.

Blaupunkt feedback

I had an interesting response from a reader regarding the story about the Blaupunkt TV in the June issue of SILICON CHIP. As you may recall, the problem was intermittent "no sound" on a Blaupunkt FM310.32 (Grundig CUC5360 chassis).

This reader, another TV technician, has an almost identical problem with a set he has at home – no sound after switch on from the mains. He says that, according to Blaupunkt in Melbourne, the fault is related to two microprocessor resets. His solution (until he finds time to fix the problem) was to simply leave the set permanently switched on and switch off to standby only with the remote control.

He also tells me that he recently serviced the Grundig equivalent that had the same fault. Like me, he replaced the TDA6610 in the stereo decoder and it instantly "cured" the fault. However, the set then came back two months later with the same problem.

According to the reader, the problem is connected with an I^2C-borne mute message, necessary because the sound amplifier chip is powered directly from the chopper power supply. This presumably is to prevent "noise" appearing in the audio immediately after switch-on from the mains – ie, after the microcontroller is up and running but before the tuner and sound detection circuits have locked in

Anyway, since writing the earlier story, my own customer had a sudden change of heart and decided to go with my modest quote. However, before returning the repaired set to him, I decided to take a few extra precautions.

The 2005 EFIL book suggests that this symptom can be caused by leakage due to dirt on the main PC board near the microprocessor. As a result, I removed, cleaned and mounted this IC and its companion EEPROM in IC sockets. I also cleaned the remote momentary switch and the PC board area around the power switch assembly.

It could well be that this is the real solution to the intermittent no-sound problem. Certainly, there have been no reports of the fault re-occurring but it's still early days yet. Who knows?

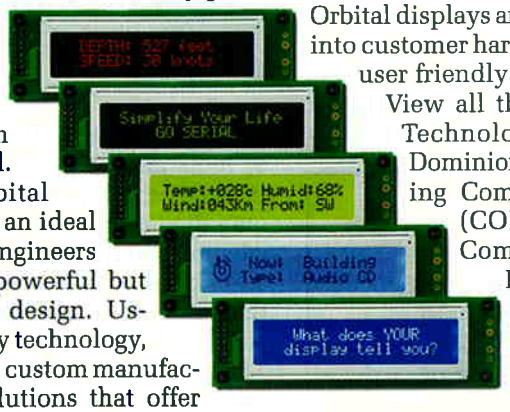
It's also interesting to note that, acting on this advice, my colleague solved his problem with the Grundig (although he also replaced the power switch).

I've now encountered a few Grundig-designed sets where high-resistance leakage problems have caused microprocessor problems and created weird symptoms. Note, however, that cleaning the board with methylated spirits is not a good idea as this is also slightly conductive. Pure alcohol and/or other PC-board cleaning solvents are much better. **SC**

PRODUCT SHOWCASE

New range of LCD, VFD & PLED displays

Dominion Electronics, the Australian distributor for Rabbit Semiconductor and Kontron Embedded Technology products, are now supplying the Asia Pacific Embedded Technology market with the latest industry proven, high performance serial and USB Liquid Crystal Displays from Matrix Orbital.



Matrix Orbital LCD units are an ideal solution for engineers who want a powerful but cost-effective design. Using proprietary technology, Matrix Orbital custom manufactures LCD solutions that offer a variety of sizes, shapes, colours, functions and innovations to meet industry demand.

Offering flexible, dependable, easy-to-program displays, these products are suitable for applications ranging from short run prototyping to large volume production runs.

Using Liquid Crystal Display (LCD), Vacuum Fluorescent Display (VFD) or the new Polymeric Light Emitting Diode (PLED) technologies, the Matrix Orbital displays are built to easily plug into customer hardware and provide a user friendly customer interface.

View all the latest Embedded Technology offerings from Dominion Electronics including Computer on Modules (COM), Single Board Computers (SBC) and Human Machine Interfaces (HMI) on the new Dominion Electronics website.

Contact:
Dominion Electronics
Unit 13, 82 Reserve Rd, Artarmon NSW 2064
Tel: (02) 9906 6988
Website: www.dominion.net.au

Jaycar boss is "desperate"

Gary Johnston, Managing Director of Jaycar Electronics, would not normally be thought of as a desperate man. After all, he has a highly successful and fast-growing electronics chain at his fingertips.

"That's exactly why I'm desperate," he told SILICON CHIP. "I want to continue the incredibly successful expansion of Jaycar Electronics throughout Australia and New Zealand and even overseas but I've reached the point where I'm stuck. I simply cannot find enough good staff to help me grow."

"Maybe my standards are too high, but that is one thing that I won't be relaxing. I know there must be good, dedicated people out there working in the wholesale and retail electronics area."

"Perhaps they are working for opposition companies and feel they are stuck in a rut, or even disillusioned with the direction their organisations are heading and would like to work for a company that is going places. Maybe not the biggest, yet, but definitely the best".

"The opportunities for advancement at Jaycar are fantastic for the right people."

"There are vacancies right now in every area of Jaycar Electronics – operations, mail order, wholesale, retail, you name it. And with the number of stores now in operation and in planning (when he can get staff!), there's bound to be a store close enough to avoid travelling," he said.

If you'd like more information about the opportunities at Jaycar, email **jobs@jaycar.com.au** in complete confidence.

Look, he's that desperate, you can even talk to Gary Johnston personally – call him on (02) 9741 8555.

Up to 190 Lumen ultrabright Luxeon Star LEDs – now in red shades

Luxeon have just released new additions to the Luxeon III Star (3W) LED range – now available from Prime Electronics.

Up to now, high power 3W LEDs have only been available in white, green, cyan, blue and royal blue.

Three additional colours are now available – red, amber and red-orange – the brightest red LEDs around, with up to 190 lumens per single source (red-amber LED)!

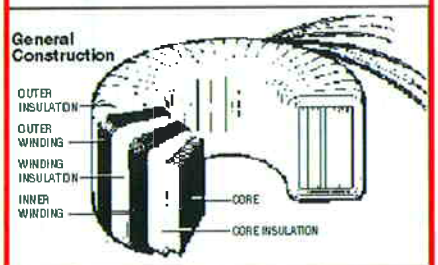
The new LEDs have lower forward voltages (typical 2.95V) but are able to be driven with an average current of 1400mA.

Peak pulsed forward current is now rated to 2200mA.

For more information, visit the Prime Electronics website or any of their showrooms (Brisbane, Sydney and Gold Coast).

Contact:
Prime Electronics
22-26 Campbell St, Bowen Hills, QLD 4006
Tel: (07) 3252 7466 **Fax:** (07) 3252 2862
Website: www.prime-electronics.com.au

TOROIDAL POWER TRANSFORMERS



Manufactured in Australia
Comprehensive data available
Harbuch Electronics Pty Ltd
9/40 Leighton Pl. HORNSBY 2077
Ph (02) 9476-5854 Fx (02) 9476-3231

Network testing gear from Microgram

Need to troubleshoot network cabling? Microgram have a couple of products which could make your life a lot simpler.

First is a Tone Generator and Probe Kit, a highly practical network installation and troubleshooting tool, which features a single or multi-tone signal, two test leads and a 4-conductor modular cable.

The signal emitted by the Tone Generator and Probe Kit can be used to verify cable continuity, identify wiring faults, determine line polarity and voltage in network (Cat 5 and Coax) and modular telephone lines.

The Probe is equipped with a tone amplifier and a LED indicator that detects audible frequency tones for accurate tracing and identification of wires.

The Tone Generator and Probe Kit is priced at $129 (Cat 11520-13).

Second is a Network Tester with LCD Display which will save you time and money. It tests a range of modular cables including 10Base-T (Category 3-5). The LCD display shows the pin connections as well as the wiring scheme detected, eg 100Base / Hub. It is priced at $149.00 (Cat 11519-13).

Contact:
Microgram Computers
1/14 Bon Mace Cl, Berkeley Vale 2261
Tel: (02) 4389 8444 **Fax:** (02) 4389 8388
Website: www.microgram.com.au

Automate, Austronics & Electrix exhibitions for September

Automate, Australia's leading hi-tech manufacturing exhibition for the automation and process industries, will be staged for the first time at Sydney Showground, Sydney Olympic Park from 13-15 September, 2005.

Automate is co-located with Austronics, Australia's International Electronics Industry Exhibition and Electrix, Australia's International Electrical Industry Exhibition, giving last year's 8479 key buyers, specifiers and decision-makers access to three major industry shows in the one visit.

The Sydney Showground is also easily accessible to other major manufacturing centres in New South Wales, allowing easier access for more key decision-makers who are keen to discover the latest manufacturing technology, including robotics & automation, instrumentation & process control, computers in manufacturing, test & measurement, hydraulics & pneumatics

Contact:
BOSCOMM Pty Ltd
Level 7, 505 St Kilda Rd, Melbourne 3004.
Tel: (03) 9868 1616 **Fax:** (03) 9868 1673
Website: www.boscomm.com.au

"Best of Show" to Integeo's Map Intelligence

Elsewhere in this issue we briefly report on CeBIT 2005. Spatial business intelligence company Integeo was awarded "Best of Show – Products and Services" for its Map Intelligence product.

Map Intelligence bridges the gap between business intelligence (BI) software and geographic information systems (GIS), allowing non-expert users to create information-rich and interactive maps from the contents of digital dashboards or spreadsheets.

No programming knowledge is required to use Map Intelligence, minimising the costs of developing a full blown GIS application.

Integeo's Australian customers include Northern Territory Police, Queensland Rail, Australian Customs Service and the Australian Department of Employment and Workplace Relations.

Contact:
Integeo
Suite 116, Bay 9, Locomotive Workshop,
Aust. Technology Park, Eveleigh NSW 1430
Tel: (02) 9209 4152 **Fax:** (02) 9209 4172
Website: www.integeo.com

New Fluke data-logging DMM package

A productivity-enhancing package of tools and accessories from Fluke includes the top-end Fluke 189 logging digital multimeter, a USB cable adapter, premium test leads and alligator clips, the Fluke 80BK temperature thermocouple, extended life battery pack, soft carrying case and the Fluke TPak magnetic hanger strap. The kit price saves the buyer more than 20% over separately sourced items.

The 189 delivers high accuracy (0.025% basic DCV accuracy) and over 20 different measurement functions. In addition, it can measure and log AC and DC voltage and current, resistance and continuity, temperature and dB, as well as perform diode tests.

Data logging gives electricians, engineers and plant technicians a tremendous productivity advantage. The Fluke 189 captures and time-stamps events that exceed limits set by the user.

The meter can log data for more than two weeks (995 points maximum), while the technician goes ahead with other productive work.

Using the FlukeView Forms software included in the Data Logging Kit, the technician can then make the logged information "come alive" on a PC display.

Compatible with Microsoft Windows, FlukeView Forms can display and overlay data from up to six DMMs on a single chart, to show cause and effect relationships or for predictive maintenance applications.

Contact:
Fluke Australia Pty Ltd
Unit 26/7 Anella Ave, Castle Hill NSW 2154
Tel: (02) 8850 3333 **Fax:** (02) 8850 3300
Web: www.fluke.com.au

Denon's new universal player first with HQV

Hollywood Quality Video (HQV) is now exclusive to Denon's latest flagship ultra Universal Player, the DVD-A1XV.

This features a new standard in DVD replay. Until now, pristine images were available only to Hollywood post-production and broadcast facilities.

The Realta HQV processing system offers professional-quality de-interlacing using four-field processing for video and film sources, noise and motion adaptive pixel-by-pixel 4D noise reduction to reduce noise for video and film sources, plus detail enhancement that improves image detail to deliver standard definition pictures that approach high-definition quality.

The DVD-A1XV employs a highly advanced video scaler. A high-precision 10-bit scaler together with a 14-bit, 216MHz video DAC designed to work with HDMI and DVI digital video output signals, obtains optimum conversion to suit the output of both. It also means that the DVD-A1XV can output digital video signals simultaneously to both outputs.

The DVD-A1-XV supports a heavy-duty drive mechanism and vibration resistance chassis construction that suppresses any internal and external vibration, often the cause of signal interference.

It is able to play virtually any digital disc including DVD, DVD-A, SACD, MP3, WMA JPEG, Photo CD, DVD/CD-R, +R, etc and offers every known current consumer based output connection including HDMI, DVI, Firewire, Denon LINK, Progressive Component, Composite, S-Video, and RGB (SCART). The DVD-A1XV also supports PAL and NTSC conversion and is THX Ultra certified.

The Denon DVD-A1XV is covered by a nationwide two-year parts and labour warranty, has an RRP of $5999 and is available at selected authorised Denon retailers.

Contact:
Audio Products Pty Ltd
67 O'Riordan St, Alexandria NSW 2015
Tel: (02) 9669 3477 **Fax:** (02) 9578 0140
Web: www.audioproducts.com.au

Epson offering big prizes in digital photo competition

Epson has launched the "Epson Color Imaging Contest 2005", one of the worlds largest photographic and graphic arts contests, with hundreds of prizes including trips to Tokyo and more than 6 million yen [about $A75,000] in prize money to share among the winners.

Photographers of all skill levels are encouraged to submit their prints in this prestigious international contest, with entries closing in Japan on 31 August 2005.

There are three major award categories:

"Color Imaging Award" is Epson's most prestigious award, aimed at artists, art school students, photographers, enthusiasts and professionals. Entries can be a colour photograph or a graphic design, computer graphic, painting, lithograph, or illustration, that explores the possibilities of graphic expression through the digital processes. First prize is two million yen [about $A24,000] and Epson products valued at about $A500.

"Nature and Human Life Photo Award" is aimed at photography enthusiasts and advanced amateurs who specialise in natural scenery, animals, plants or human portraits. There are two first prizes of one million yen [about $A12,000] and Epson products valued at about $A500. They are for the best nature print of natural scenery, animals, plants and insects; and for the best human life print of people or man-made objects.

"Family Snap Award" is for people who just love taking photographs of family members, friends, pets, scenery, sports, events, travel and holidays. There are three main prizes worth a total of 800,000 yen [about $A10,000] and numerous smaller prizes.

Held since Epson introduced the first colour inkjet printer to the market in 1994, the contest allows Epson to help promote new forms of expression through digital printing and create a vibrant digital photo culture.

Details of how to enter, prizes and entry forms can be found at: https://www.clubepson.com.au/competitions/competitions/2005_61/competition.asp

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JED designs and manufactures a range of single board computers (based on Wilke Tiger and Atmel AVR), as well as LCD displays and analog and digital I/O for PCs and controllers. JED also makes a PC PROM programmer and RS232/RS485 converters.
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Tel: 1800 022 888
WebLINK: www.jaycar.com.au

This easy-to-build unit plugs into the serial port of your PC and can control up to four separate stepper motors via suitable driver boards. Alternatively, you can cascade up to four units to control up to 16 steppers. It's easy to program too.

By GREG RADION

Serial Stepper Motor Controller

UNTIL NOW, IT HAS BEEN relatively difficult for the experimenter to properly control stepper motors using a computer. That's because most stepper motor kits sold today interface the step and direction inputs to a parallel port and then require you to write the software to switch these inputs.

If you need to incorporate limit switches and acceleration and deceleration of the stepper motor, what started out as a simple job turns out to be complicated and time consuming. What's more, parallel port designs can generally control only one or two motors and some designs don't allow multiple boards to be cascaded together.

The Serial Stepper Motor Controller (SSMC) described here overcomes these problems. It's a relatively compact microcontroller-based design that attaches to a PC's serial port and provides control for up to four stepper motors (via a suitable driver board). What's more, it does away with the need for special software to control the acceleration and deceleration of the motors. Instead, you just issue the basic commands and the software inside the microcontroller does all the hard work for you.

It's really very easy to program. There are just nine commands (see Table 2) and these are all entered via a standard serial terminal program (eg, HyperTerminal). We'll have more on this later.

Want to control more than four steppers? No problem – up to four Serial Stepper Motor Controller boards can be cascaded (or "ganged") together and individually addressed. This allows you to control up to 16 stepper motors, all from the one serial port.

You can't do that with most parallel port designs and, in any case, the parallel port is rapidly disappearing (many laptops no longer include a parallel port, for example). And with the availability of cheap USB-to-serial converters, this controller could easily be adapted for use on any USB port.

Fig.1 shows how the SSMC boards are connected. Note that the SSMC board does not directly drive the motors, since it has no on-board driver circuitry. Instead, each stepper motor is driven via a separate driver board.

There are several stepper motor driver kits available that can be used with the SSMC board. These include kits K179 (unipolar) and K142B (bipolar) from Oatley Electronics. The unipolar driver board was originally published as the Mini-Stepper Motor Driver in the May 2002 issue of SILICON CHIP. It can control both 5-wire and 6-wire unipolar stepper motors, while the bipolar board controls 4-wire and 6-wire motors.

Each of these kits has step and direction signal inputs which allow the user to control the movement of the motor. The Serial Stepper Motor Controller simply connects to these step and direction inputs on the driver cards.

Stepper motors

Before moving on to the circuit

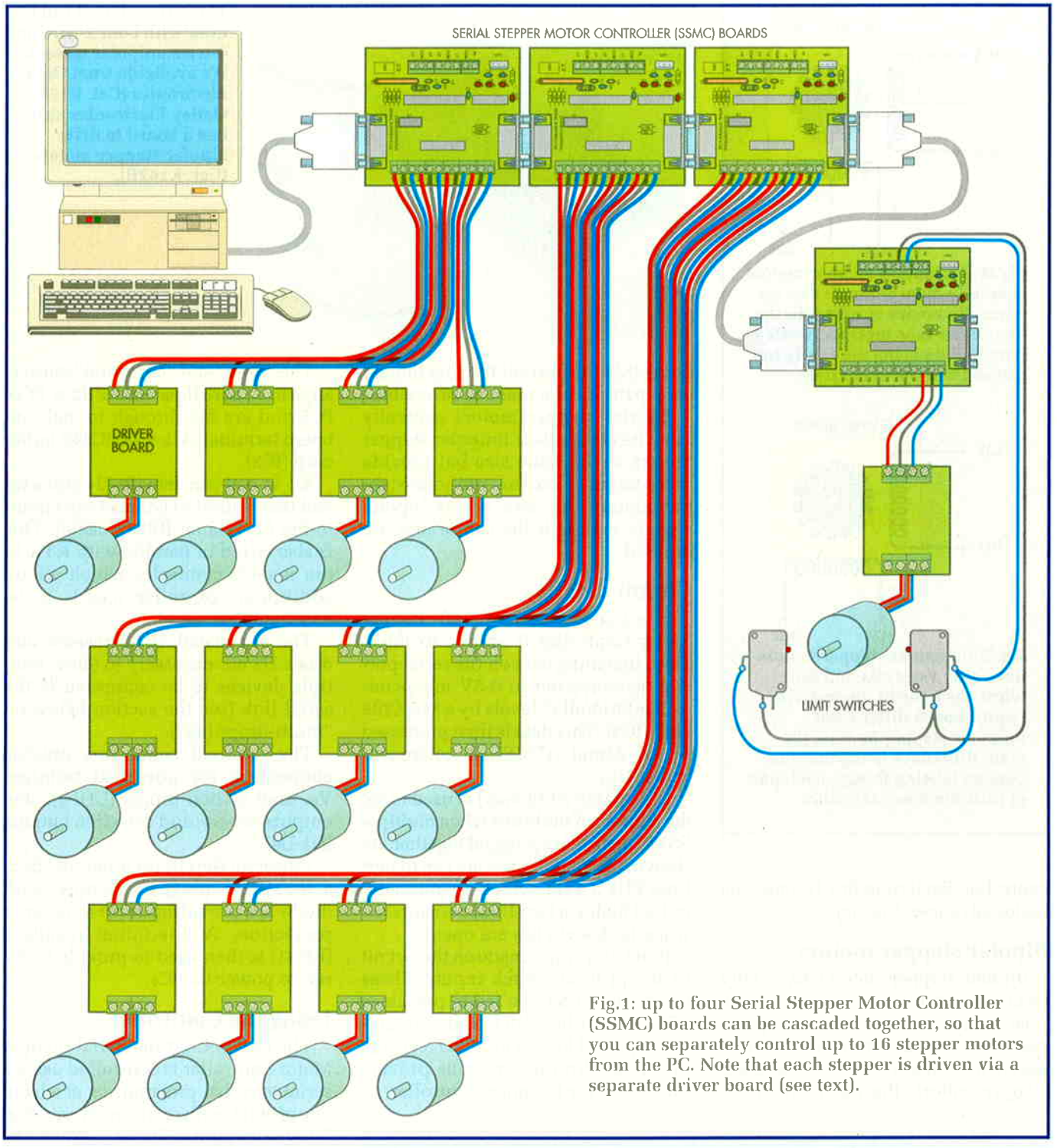


Fig.1: up to four Serial Stepper Motor Controller (SSMC) boards can be cascaded together, so that you can separately control up to 16 stepper motors from the PC. Note that each stepper is driven via a separate driver board (see text).

description, let's take a closer look at the way stepper motors work. Unlike regular DC or AC motors which have commutator brushes to automatically switch the stator coils, stepper motors have no brushes. Instead, the coils inside a stepper motor are individually switched by the stepper motor control circuit.

The accompanying panel explains the differences between conventional motors and stepper motors in greater detail.

There are two main types of stepper motor: unipolar and bipolar. Let's take a look at each type in turn.

Unipolar stepper motors

Most unipolar stepper motors contain two centre-tapped coils and these effectively act as four individual coils – see Fig.2(a). These motors have either five or six wires. Five-wire motors join the two centre taps together, while 6-wire motors bring out the centre tap connections individually.

In addition, there are 8-wire unipolar stepper motors and these have four individual coils, with a wire for each end of each of the coils.

The four coils of a unipolar stepper motor are individually activated and deactivated sequentially by the

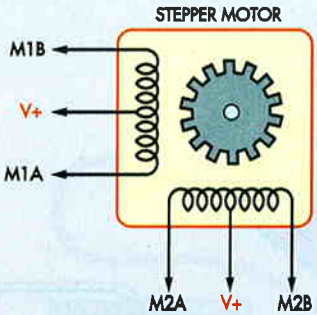


Fig.2(a): unipolar stepper motors generally have either five or six wires. Five-wire motors join the two centre taps together, while 6-wire motors bring the centre tap connections out separately.

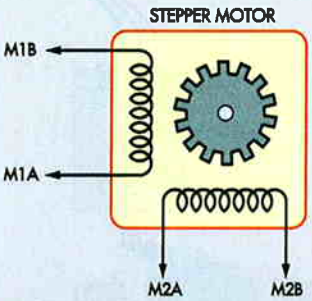


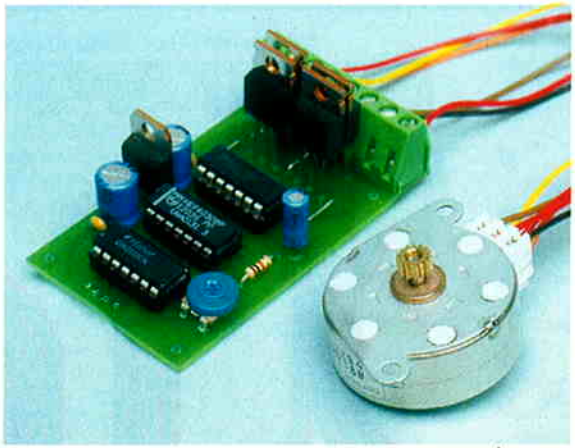
Fig.2(b): bipolar stepper motors have only two coils and four wires. As a result, their drive requirements differ from unipolar stepper motors, the main difference being that the current flowing though each pair of coils must be reversible.

controller. Each time this is done, the motor advances one step.

Bipolar stepper motors

Bipolar stepper motors have only two coils and four wires – see Fig.2(b). That means that the drive requirements for bipolar stepper motors is somewhat different to that of unipolar stepper motors, the main difference being that the current flowing though each pair of coils must be reversible.

Bipolar stepper motors generally have less steps than unipolar stepper motors of the same size but provide more torque. Note that unipolar stepper motors can also act as bipolar stepper motors if the centre taps are omitted.



This driver board can be used with both 5-wire and 6-wire unipolar motors. It's available from Oatley Electronics (Cat. K179). Oatley Electronics also has a board to drive bipolar stepper motors (Cat. K142B).

Circuit details

The circuit for the Serial Stepper Motor Controller is shown in Fig.3. First, incoming data on the serial port (K2) is converted to 0-5V microcontroller "friendly" levels by a MAX232 chip (IC3). This data is then processed by an Atmel ATMEGA8 microcontroller (IC).

DIP switch S1 (2-way) is used to set the address of the board when multiple SSMC boards are plugged together. As shown, the switch lines are run to port lines PD2 & PD3, which are normally pulled high via two 10kΩ resistors (ie, when both switches are open).

Provision is also made on the circuit to accept limit switch inputs. These inputs (LS1-LS4) are fed to port lines PD5-PD7 & PB0 which again are normally pulled high. The 10kΩ resistors in series with the port pins provide protection for the microcontroller.

The "Step" and "Direction" outputs appear at port lines PB1-PB2 & PC0-PC5 and are fed through to their on-board terminals via a 74HC245 buffer chip (IC3).

K2 is a 9-pin female D-connector and this is used to connect the circuit to the PC (via an RS232 cable). This is also wired in parallel with K3, a 9-pin male D-connector which allows additional controller boards to be connected.

The associated 18kΩ resistor and diode D2 are necessary to allow multiple devices to be connected to the serial link (see the section below on "multi-dropping").

The terminal connectors provide connection for power at terminal Vs, limit switch inputs (L1-L4), step outputs (S1-S4) and direction outputs (D1-D4).

Power for the circuit is derived from a 9-12V DC plugpack supply, with diode D1 providing reverse polarity protection. A 3-terminal regulator (REG1) is then used to provide a +5V rail to power the ICs.

Using the Controller

The Ocean Controls Serial Stepper Motor Controller is controlled using a serial terminal program, set at a baud rate of 9600, with one start bit, one stop bit and no parity. The accompanying panel shows how to set up HyperTerminal, which comes with Windows.

The commands for the controller take the form:

@AA CMND XXXX

where AA is the 2-digit number of the motor being addressed (between 01 and 16 - see Table 1), CMND is the 4-letter command (see Table 3), and XXXX is a numeric value associated with the command (see Table 2).

When a valid command is received

Where To Buy A Kit

The Serial Stepper Motor Controller was developed by Ocean Controls, 4 Ferguson Drive, Balnarring, Vic and all copyright is retained by Ocean Controls. Prices are as follows:

(1) Full kit of parts for SSMC (Cat. KT-5190) ..... $55.00 + GST

(2) Fully assembled SSMC unit (Cat. KT-5190A) ..... $65.00 + GST

Visit the company's website at **www.oceancontrols.com.au** for pricing and ordering details, or phone (03) 5983 1163. Note: prices do not include postage.

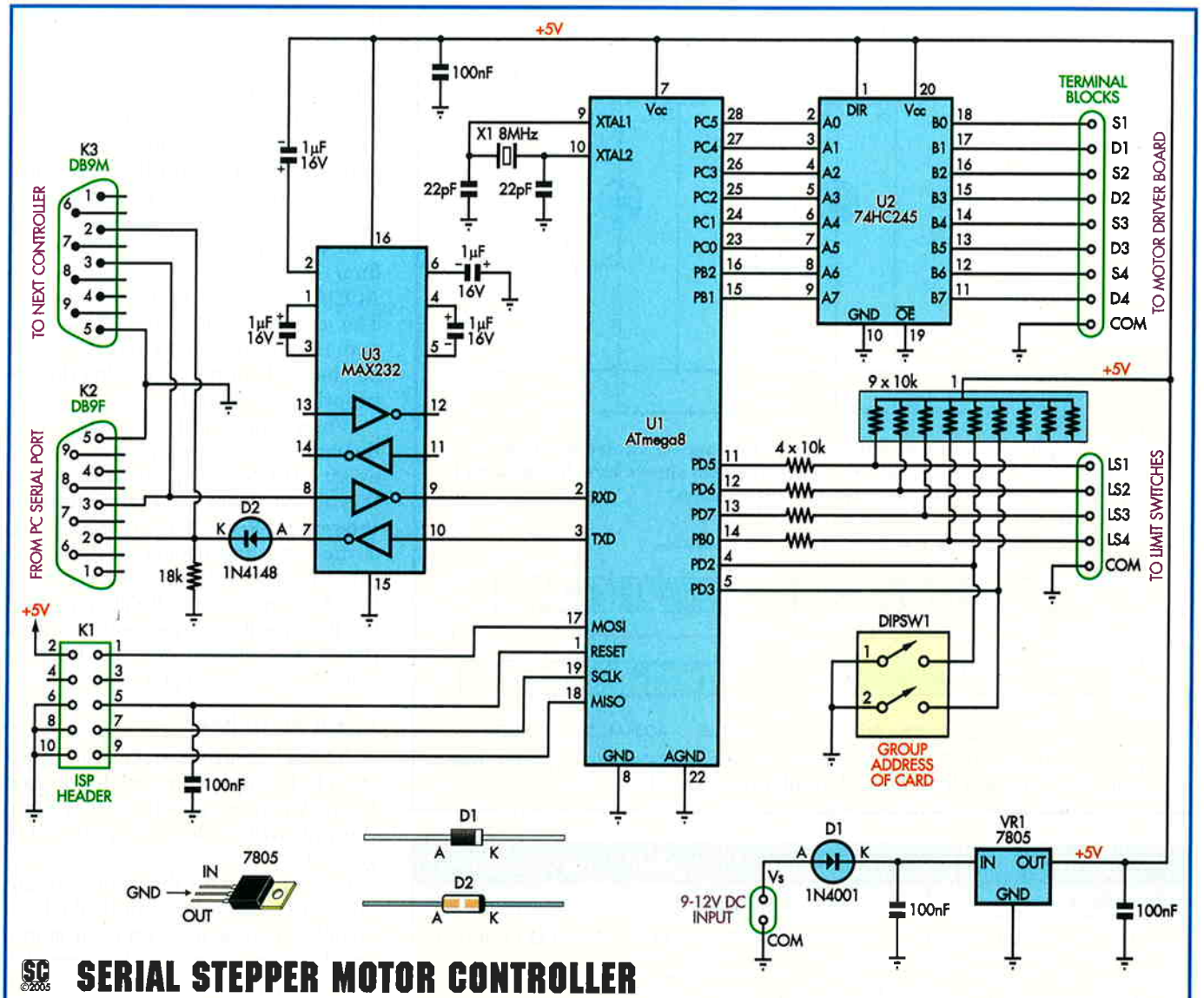


Fig.3: the complete circuit for the Serial Stepper Motor Controller. The MAX32 chip (IC2) converts the RS232 data to TTL levels and this data is then processed by microcontroller IC1 to derive the step and direction control signals.

by the unit, it responds with the address preceded by a hash symbol – ie, #AA – and this is followed by a value if it is requested.

Status command detail

The status command returns the state of each of the motors attached to a single controller board. Valid "stat" commands have the address of the first motor on the board, eg:

@01 STAT returns the status of motors 01-04
@05 STAT returns the status of motors 05-08
@09 STAT returns the status of motors 09-12
@13 STAT returns the status of motors 13-16

These are the four valid status commands. The returned value is a 12-bit binary representation indicating whether the motors are moving, their direction and the state of the limit switches. Table 3 shows the general format.

Multi-dropping

"Multi-dropping" is the term used when connecting multiple slaves to one master. This is achieved by including a signal diode on the transmit outputs of the slaves, plus a resistor to pull the transmit line to ground when it is not being used. The diode prevents voltages produced by transmitted data from the slaves appearing on the transmit pins of the other slaves.

All the slaves receive the same data from the master and decode it if necessary.

Fig.4 shows the basic scheme for multi-dropping. Note that the 18kΩ pull-down resistor and the diode (D2) are included in the circuit, so you don't have to worry about adding these if you do decide to connect several units together. All you have to do is plug

Table 1 – Addressing

S2	S1	Motor Numbers
Off	Off	01-04
Off	On	05-08
On	Off	09-12
On	On	13-16

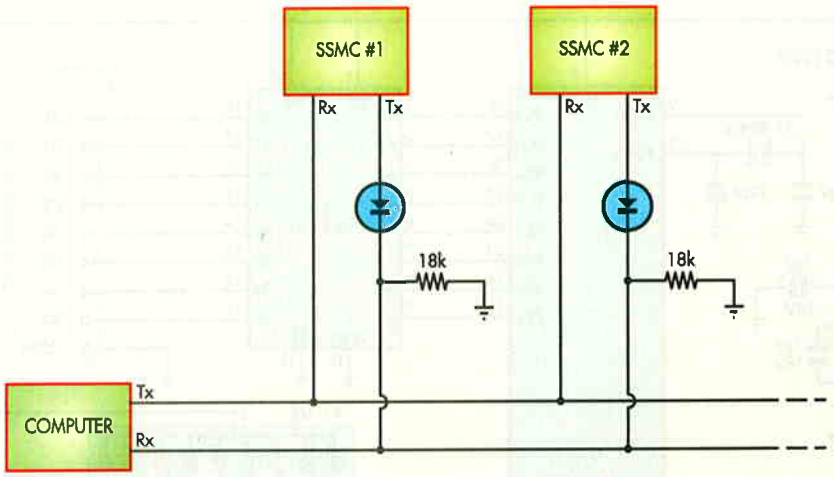


Fig.4: multiple slaves can be connected to one master controller using a technique called "multi-dropping". This diagram shows how the scheme is implemented using diodes and pull-down resistors.

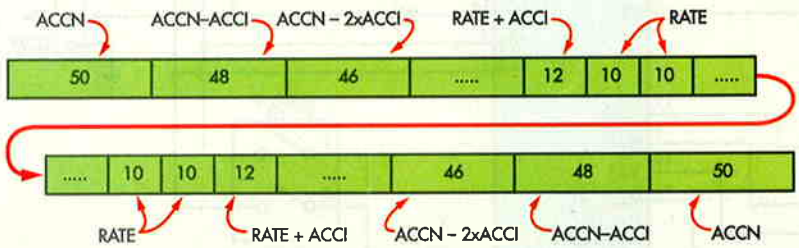


Fig.5: the microcontroller on the SSMC board calculates the stepping times to determine the acceleration and deceleration – see text.

Table 2 – Use These Commands To Control Your Stepper

Command	Description
POSN	Set the position that motor AA is currently at to XXXX, where XXXX is between -99,999,999 and 99,999,999.
PSTT	Returns the position of motor AA.
AMOV	Move motor AA to absolute position XXXX, where XXXX is between -99,999,999 and 99,999,999.
RMOV	Move motor AA relatively from the current position by XXXX, where XXXX is between -99,999,999 and 99,999,999.
STOP	Stop motor AA immediately.
STAT	Get the status of the motors (see "Status Command Detail" section in text).
ACCN	Set the maximum stepping rate in milliseconds of motor AA to XXXX, where XXXX is between 0 and 9999 (see "Acceleration"). If the value for ACCN is 0 or less than RATE, then no acceleration or deceleration occurs.
ACCI	Set the Acceleration interval in milliseconds of motor AA to XXXX, where XXXX is between 1 and 9999 (see "Acceleration").
RATE	Set the minimum stepping rate in milliseconds of motor AA to XXXX, where XXXX is between 1 and 9999 (see "Acceleration").

Table 3 – Status Value

msb	11	10	9	8	7	6	5	4	3	2	lsb
L4	L3	L2	L1	D4	D3	D2	D1	M4	M3	M2	M1

Where M, D and L represent the movement, direction and limit switches respectively.
For movement: 1 = moving, 0 = stopped. For direction: 1 = forward, 0 = reverse.
For limit switches: 1 = closed, 0 = open.

the SSMC boards together, as shown in Fig.1.

Acceleration

Each time a command to move a stepper motor is issued, the Serial Stepper Motor Controller calculates the stepping times to give a gradual acceleration and deceleration.

In operation, the acceleration and final speed are determined by the ACCN, ACCI and RATE parameters. The default values are 50ms, 2ms and 10ms respectively but these can be changed simply by issuing the appropriate command.

When a command is issued to move the motor, it starts stepping at one step every "ACCN ms" and then decreases this by "ACCI ms" every step until the interval is "RATE ms". Subsequently, as the motor approaches the final position, the step interval then increases by "ACCI ms" from "RATE ms" until the final position is reached, at which point the interval will be back to "ACCN ms" – see Fig.5.

Limit switches

As stated previously, the limit switch inputs are normally pulled high. An input is activated when a limiting switch closes and pulls it to ground.

Fig.7 shows how the limit switches are wired. Note that multiple limit switches can be used on each motor, provided they are wired in parallel. Note also that normally open (NO) switches must be used.

When a limiting switch closes, the associated motor stops. If the switch remains closed, the motor will then only perform a single step in response to each subsequent command issued. This can be used to back the motor off the limit switch one step at a time, for example.

Assembly

The assembly is straightforward, with all parts mounted on a double-sided PC board with plated through holes. Fig.6 shows the parts layout.

Start the assembly by installing the resistors and diodes, taking care to ensure that the diodes are correctly oriented. The 9 x 10kΩ SIL resistor package can also be installed at this stage. It must be oriented with the white dot on the package (ie, pin 1 – the common connection) to the left.

That done, install the capacitors and

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the crystal, followed by the IC sockets, voltage regulator REG1 and the DIP switch. Take care with the orientation of the DIP switch – the "ON" marking goes towards the terminal block. Regulator REG1 must be mounted with its metal tab towards the two 100nF capacitors.

Next, add the screw terminal blocks and the two 9-pin "D" connectors (K2 & K3). The DB9F (female) connector is mounted on the left, while the DB9M (male) connector goes to the right. **K1 (a 2 x 5-way pin header) is for in-circuit programming but is not supplied as part of the kit.**

Note also that if you are going to gang two or more controller boards together, you will need to remove the screw posts from the DB9M connectors. This is necessary to allow the male and female connectors to mate correctly when pushed together.

Don't install the ICs yet – that step comes later, after the supply rail has been checked.

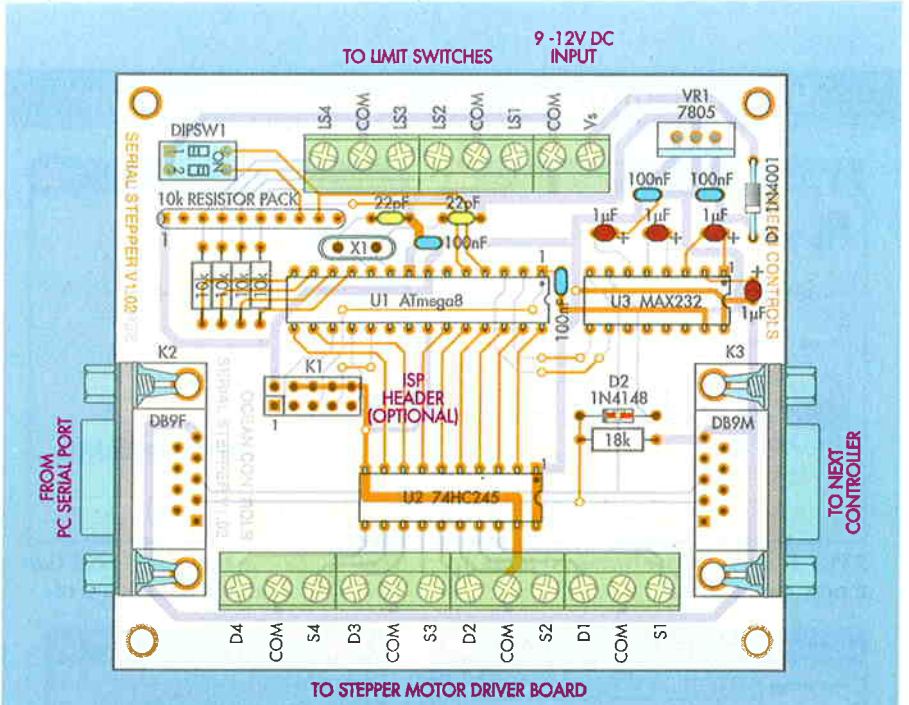


Fig.6: install the parts on the PC board as shown on this wiring diagram. Note that pin header K1 is for in-circuit programming (ISP) but is not supplied as part of the kit since IC1 is supplied preprogrammed.

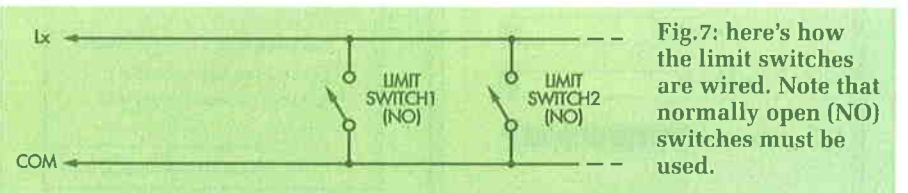


Fig.7: here's how the limit switches are wired. Note that normally open (NO) switches must be used.

Testing

To test the controller, first connect power (to Vs & COM) and measure the voltage across pins 10 & 20 of IC2's socket. You should get a reading of 5V. If not, switch off immediately and check that you have installed the regulator (REG1) correctly.

If you do get 5V, remove the power and push the ATMEGA-8 microcontroller (IC1), 74HC245 (IC2) and MAX232 ICs into their sockets. Take care to ensure that these ICs are all correctly oriented – each device is installed with its notched (pin 1) end towards the right, as shown in Fig.6. Make sure too that all the IC pins go into the sockets and that none are folded underneath the IC or splayed out down the side of the socket.

Once all the ICs are in, connect the board to the computer using an RS232 cable and reconnect power. Set the DIP

How A Stepper Motor Works

Stepper motors are everywhere. For example, every computer contains several (ie, in the floppy and hard disk drives). They're used because it is easy to achieve very precise positional control – far better than you can achieve with a "normal" motor.

Unlike a conventional motor, where you simply connect an appropriate voltage and "away she spins", stepper motors require considerably more effort to get them to work.

First of all, think of a conventional motor. It has two main components – a stator, which sets up the magnetic field, and a rotor, which by magnetic attraction or repulsion turns towards or away from the magnetic field.

There's also a commutator (actually part of the rotor) which keeps switching power from one coil to the next, moving the magnetic field as well, so the rotor has to keep moving, or rotating.

Stepper motors are similar in many respects – they have stators and they have rotors – but they don't have commutators. The magnetic fields which cause attraction/repulsion, and therefore cause the rotor to turn, are set up externally by the motor controller.

In a stepper motor, one stator coil is first energised, repelling the rotor. Then that coil is de-energised and the next one energised, again repelling the rotor. Keep this up and the rotor turns continuously. By controlling which field coils are energised and when, the rotation and stopping position of the rotor can be precisely controlled.

You will hear stepper motors referred to as 0.9°, 1.8° and 3.6° types, and so on. This refers to the angle of rotation for one "step" of the motor – eg, a 0.9° motor makes 400 individual steps to complete one full rotation of 360°.

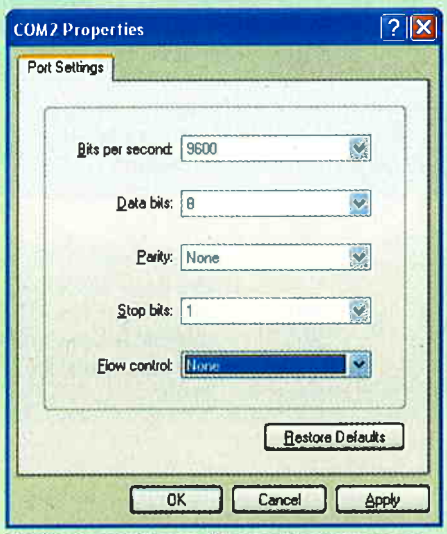
That's a lot of steps, especially as each one can be individually accessed. And many stepper motors operate through a gearbox, multiplying that yet again.

The speed of rotation is directly related to how fast you can switch current between the coils. This is no problem at low speeds but can cause problems as the switching frequency increases.

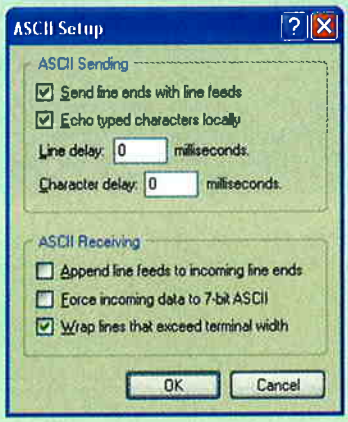
How To Configure The Terminal Program

STEP 1: open HyperTerminal & set up a new connection.

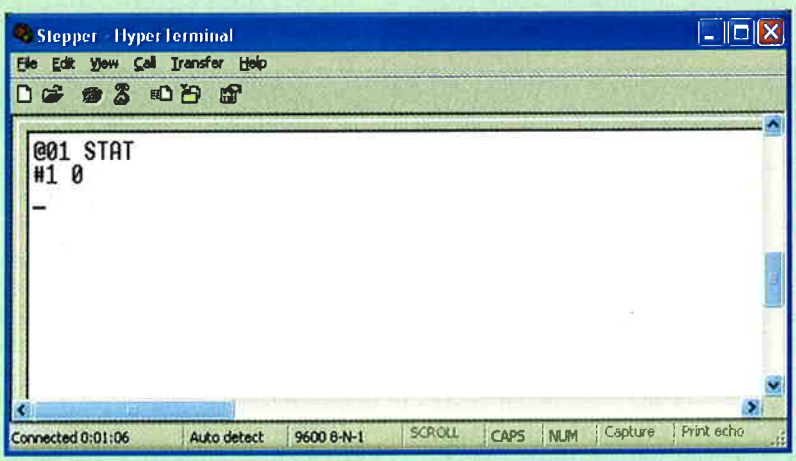
STEP 2: choose that COM port that the SSMC board is connected to.



STEP 3: configure the port settings as shown here.



STEP 4: click File, Properties, Settings, ASCII Setup and select the "Send line ends with line feeds" and "Echo typed characters locally" functions.



STEP 5: entering the *@01 STAT* command should return *#01 0* if the board is working correctly and nothing else is connected.

switches so they address from 01-04 (ie, both off) and then run a terminal program at 9600 baud and type **@01 STAT** and press the Enter key.

This should return **#1 0** if the unit is working properly and nothing else is connected.

If you have an oscilloscope, you can give a move command such as **@01 RMOV 1000** and view the pulses at terminal S1 to confirm that the unit is working. Alternatively, if you don't have an oscilloscope, you will have to connect the unit to a driver board and stepper motor. Just connect the driver board (with its stepper) to the S1, D1 and COM terminals and issue the above move command – the motor should immediately move in response.

If it does, your SSMC board is working correctly and you can start programming more ambitious control sequences.

Example program

An example Visual Basic program with source code for controlling four motors is available on the Ocean Controls website at **www.oceancontrols.com.au**. This program can easily be expanded to control up to 16 motors for virtually any stepper-motor application. **SC**

Parts List

2 14-pin DIP sockets (for IC1)
1 16-pin DIP socket
1 20-pin DIP socket
1 2-way DIP switch (S1)
1 DB9F right-angle connector (K2)
1 DB9M right-angle connector (K3)
6 3-way 5.08mm screw terminal blocks
1 2-way 5.08mm terminal block (T2)
1 8MHz crystal (X1)

Semiconductors
1 Atmel ATMEGA-8 programmed microcontroller (IC1)
1 74HC245 octal buffer (IC2)
1 MAX232 RS232-to-TTL level shifter (IC3)
1 7805 5V regulator (REG1)
1 1N4004 silicon diode (D1)
1 1N4148 silicon diode (D2)

Capacitors
2 22pF ceramic (C1, C2)
4 0.1µF monolithic (C3-C6)
4 1µF electrolytic (C7-C10)

Resistors
1 9 x 10kΩ 10-pin SIL resistor array
4 10kΩ (R1-R4)
1 18kΩ (R5)

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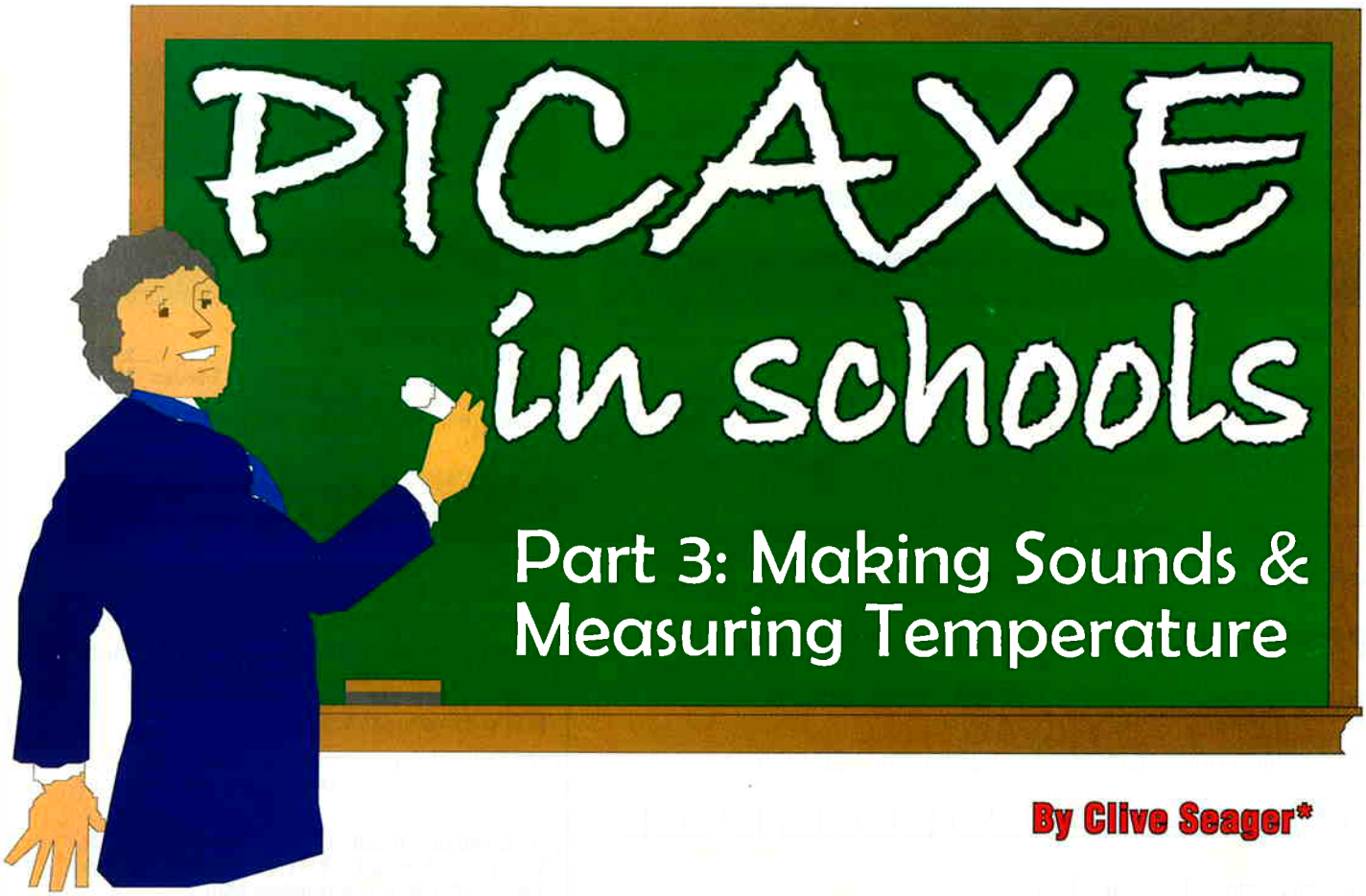


Part 3: Making Sounds & Measuring Temperature

By Clive Seager*

Last month, we programmed our Schools Experimenter board to respond to digital and analog inputs. This month we'll see how to use a sophisticated sensor for temperature measurement and have some fun playing mobile phone ring tones!

In this article you will learn:

- how to make sounds and play tunes;
- how a *for...next* loop operates;
- how to connect and use a digital temperature sensor.

Sounds in electronic projects are usually generated with an electromechanical or piezo buzzer. We'll describe only the piezo type here, as they use much less power than the electromechanical types and are well suited for use in battery-powered circuits.

A typical piezo buzzer contains two main parts: a piezoelectric transducer and its driving circuit. The piezo transducer consists of a polarised ceramic material bonded to a metal disc.

A voltage applied to opposite sides of the disc will cause it to flex, so by applying a varying voltage, it can be made to vibrate and produce an audible sound. The built-in driving circuit in a buzzer generally applies a voltage that varies (or "oscillates") at a single frequency, resulting in a monotonous, irritating tone.

In conjunction with the **sound** command, PICAXE micros can generate a voltage at an output pin that oscillates at a programmable frequency. By connecting a piezoelectric transducer (without the inbuilt driver circuit) to that pin, we can therefore make our own buzzer for signalling purposes – and much more.

Making sounds

In use, three numbers must follow the **sound** command. The first is simply the output pin number that is to be driven and on the Schools Experimenter board, this will always be output 2. The second number is the desired pitch of the sound and can be between 0 and 127. As one might expect, a higher number generates a higher frequency signal. The third number is the length of the sound in approximately 10ms steps.

The simple program in Listing 1 shows how to use the **sound** command. In this example, three sequential tones of equal duration are produced. Listing 2 shows how the three lines can be combined into a single command to save PICAXE memory space.

Note that on the Schools Experimenter board, the piezo transducer and green LED share the same output (*output 2*), so the green LED will flicker as the sound is being generated.

For...next loops

Often it is useful to repeat a section of BASIC code a number of times. For example, if you wish to flash the yellow LED (on *output 1*) five times, you can use a *for...next* loop as shown in

* About the author: Clive Seager is the Technical Director of Revolution Education Ltd, the developers of the PICAXE system.

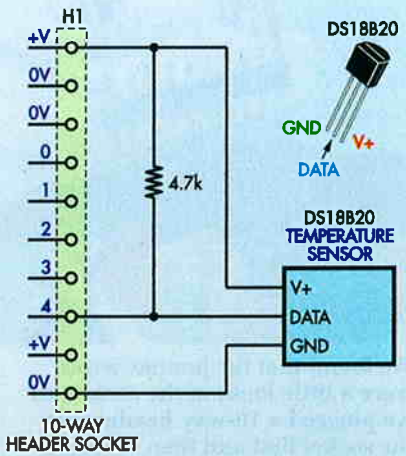


Fig.1: the digital output from the DS18B20 temperature sensor connects to *input 4* of the PICAXE micro via the header socket (H1), as shown here. The sensor also requires power (+V) and ground (0V) connections and a 4.7kΩ pull-up resistor.

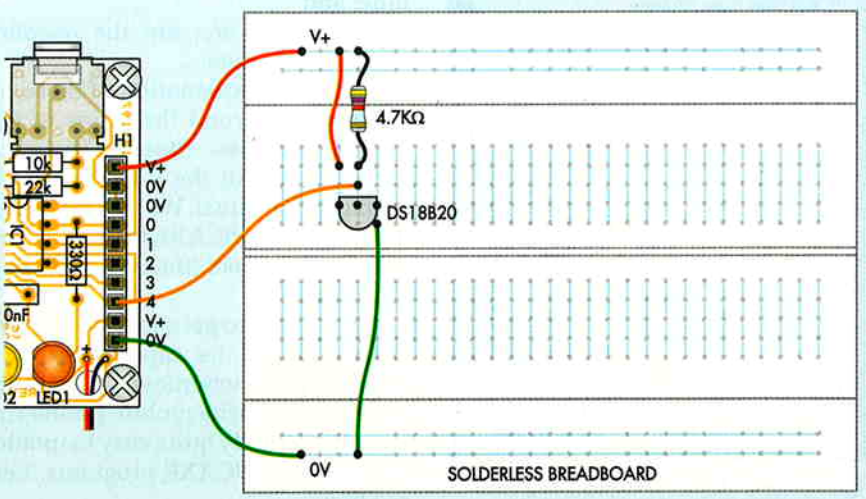


Fig.2: here's how to wire up the sensor using a small solderless breadboard. The jumper wires can be purchased in pre-cut lengths, or you can make your own with solid-core alarm cable and wire strippers.

Listing 3. In this example, variable *b1* (*b* for "byte") is used as a counter to keep track of the number of loops completed.

Task – write a program that flashes the green LED 10 times when the switch on *input 3* is pressed (you might need to look at last month's article about inputs for a reminder).

We can use the same *for...next* structure to make the piezo play every possible note using the **sound** command, as shown in Listing 4. The second *for...next* loop in this example shows how to repeat the scale in reverse by using a step value of -1 (the default step value is +1).

Playing built-in tunes

The **sound** command is great for making simple "beep" noises but is not well suited for playing musical tunes. Instead, the PICAXE-08M offers the **play** and **tune** commands for this purpose. These musical commands operate on *output 2* only, so unlike the **sound** command, the **play** and **tune** commands do not need an output pin number.

The **play** command is used to play one of the four internally pre-programmed tunes, which are: Happy Birthday, Jingle Bells, Rudolf the Reindeer and Silent Night. For example, the program in Listing 5 could be used to play a tune when the lid of a box is lifted (a "birthday box", perhaps). As described last month, the program makes use of the LDR to sense light level, allowing it to play the tune only at the appropriate moment.

Two numbers follow the **play** command, both of which can take the value 0 to 3. The first number represents the tune (0 = Happy Birthday, 1 = Jingle Bells, etc). The second number can be used to flash LEDs connected to *output 0* and/or *output 4*. We will not use this function in our experiments, so the second number should always be 0.

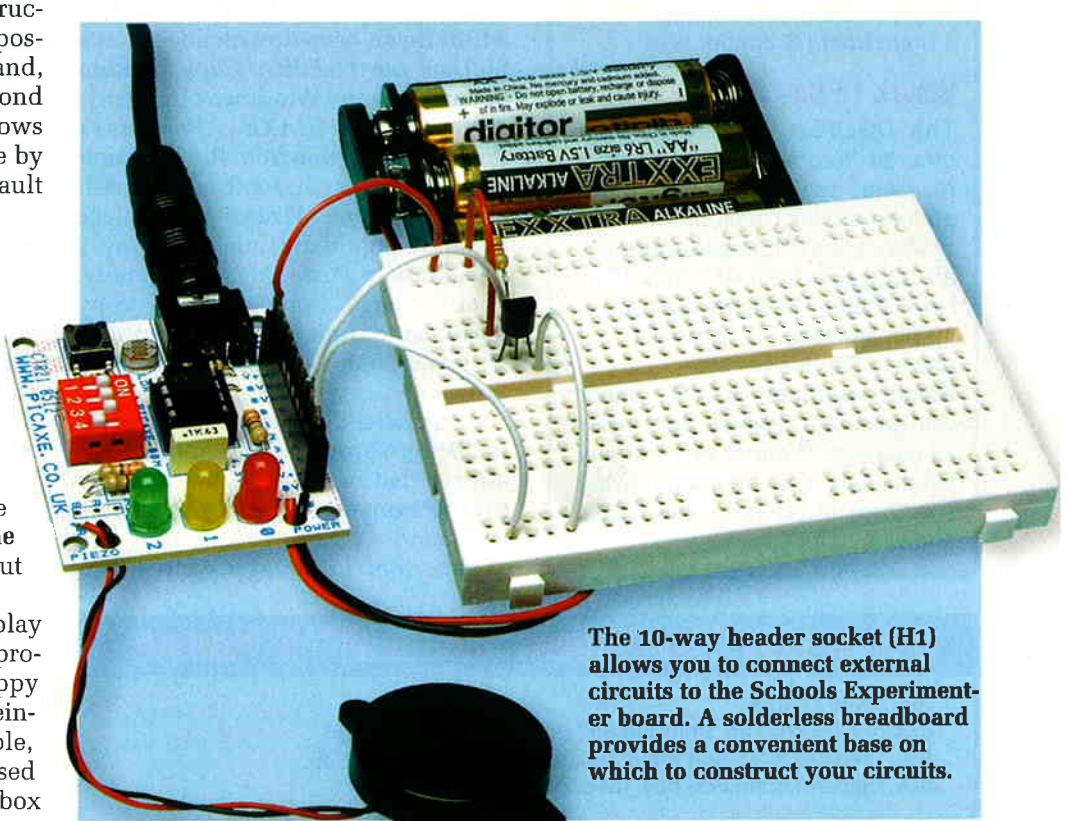
Playing your own tunes

The **tune** command is used when you want to compose your own tunes or import them using the Programming Editor, as we'll see shortly. The **tune** command has the following syntax:

***TUNE** LED, speed, (note, note, note...)*

where:

- *LED* is a variable/constant (0 -3) that



The 10-way header socket (H1) allows you to connect external circuits to the Schools Experimenter board. A solderless breadboard provides a convenient base on which to construct your circuits.

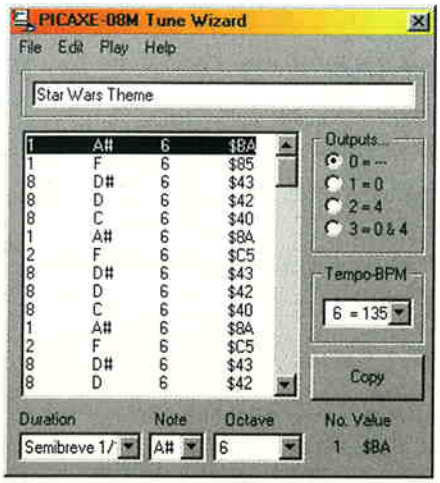


Fig.3: import RTTTL tunes or create your own with the Tune Wizard, included in versions 4.0.1 and later of the PICAXE Programming Editor

specifies if *output 0* and/or *output 4* toggle at the same time as the tune is being played. This can be used to flash LEDs but is not used in our experiments and should always be 0.

- *speed* is a variable/constant (1-15) which specifies the tempo of the tune; and
- *note, note,* etc, are the encoded musical note data.

A detailed explanation of these parameters is beyond the scope of this beginner's series. More information can be found in the PICAXE BASIC Commands manual. We also published details in the "PICAXE the Red-Nosed Reindeer" project (SILICON CHIP, September 2004).

A good way to get a feel for the **tune** command and its capabilities is to import a ready-composed tune in the form of a favourite mobile phone ring tone. It's actually quite easy to include ring tones in PICAXE programs. Let's see how.

Importing ring tones

With a little help from the Programming Editor and its *Tune Wizard*, any monophonic mobile phone ring tone can be imported and automatically formatted for use with the **tune** command.

Ring tones must be in RTTTL (ring tone text transfer language) format for use with this system. These are available from a number of internet websites, including Revolution Education's site at **www.picaxe.co.uk**.

An example ring tone in RTTTL format is given in Fig.4. The first step to importing a ring tone is to highlight its text in Internet Explorer (or any text editor if you have downloaded it as a file) and use the *Edit -> Copy* function to copy it to the Windows clipboard.

Next, select *PICAXE -> Wizards -> PICAXE-08M Tune* from the Programming Editor's main toolbar. This will open the "Tune Wizard" screen (see Fig.3). To import the tune data, simply select *Edit -> Paste ring tone*. Finally, click the large "Copy" button to copy the formatted **tune** command complete with ring tone data into your BASIC program.

As a matter of interest, the program in Listing 6 provides similar functionality to that in Listing 5 but uses the **tune** command instead of the **play** command.

Important: in Listing 6, we've divided the note data for the ***tune*** *command over several lines but in the Programming Editor, all note data must appear on a single line.*

Task – import a ring tone and write a program that will play the tune when the switch is pressed and the light level (sensed using the LDR) is low.

Parts List

1 DS18B20 temperature sensor IC
1 4.7kΩ 0.25W 5% resistor
1 10-pin SIL header socket
1 breadboard & jumper wire

Where To Buy Parts

The DS18B20 sensor can be ordered from MicroZed and their resellers, see **www.picaxe.com.au** for more information.

Single-in-line (SIL) header sockets are available from Altronics (Cat. No. P-5390). These are supplied in 40-pin sections but are easily cut down to the desired size.

Breadboards and pre-cut jumper wire packs are available from major kit suppliers. Jumper wires of any length can also be made using solid-core telephone or alarm cable and wire strippers.

Fig.4: Star Wars Theme Tune In RTTTL Format

```
Star Wars Theme:
d=4,o=5,b=125:1a#,1f6,8d#6,8d6,8c6,1a#6,2f6,8d#6,8d6,
8c6,1a#6,2f6,8d#6,8d6,8d#6,2c6,8f,8f,8f,2a#,2f6,8d#6,8d6,
8c6,1a#6,2f6,8d#6,8d6,8c6,1a#6,2f6,8d#6,8d6,8d#6,1c6
```

We found that the jumper wires were a little loose in the socket, so we plugged a 10-way header into the socket first and then soldered our wires to that to ensure reliable connections.

Digital temperature sensor

Last month, we used the on-board light-dependant resistor (LDR) and some simple programs to measure relative ambient light levels. In theory, we could use a thermistor (temperature sensitive resistor) and a similar scheme to measure temperature.

However, thermistors are typically non-linear devices and our measurements would need considerable manipulation to give accurate results in degrees Celsius. An easier way is to use a DS18B20 digital temperature sensor IC. These devices contain an accurate temperature measurement circuit, with a digital output for direct interfacing to our PICAXE chip.

The DS18B20 sensor's digital output connects to *input 4* of the PICAXE via the 10-way header socket (see Fig.1). If you haven't already installed this header, then you should do that next.

Rather than plugging the sensor pins directly into the header, it is easier to plug it into a small external breadboard. Connections between the breadboard and header can then be made with solid-core wire, as depicted in the accompanying photograph and on Fig.2. As shown, a 4.7kΩ resistor is also required for correct operation.

Note that as *input 4* is already used by the LDR, it must be disconnected

Program Listings

Listing 1
```
main:
  sound 2,(50,50)
  sound 2,(80,50)
  sound 2,(120,50)
  pause 1000
  goto main
```

Listing 2
```
main:
  sound 2,(50,50,80,50,120,50)
  pause 1000
  goto main
```

Listing 3
```
main:
  for b1 = 1 to 5
  high 1
  pause 100
  low 1
  pause 100
  next b1
end
```

Listing 4
```
main:
  for b1 = 0 to 127
  sound 2,(b1,20)
  next b1
  for b1 = 127 to 0 step -1
  sound 2,(b1,20)
  next b1
  goto main
```

Listing 5
```
main:
  readadc 4,b1
  if b1 > 80 then play_tune
  goto main

play_tune:
  play 0,0
  goto main
```

Listing 6
```
main:
  readadc 4,b1
  if b1 > 80 then play_tune
  goto main

play_tune:
  tune 0, 6,($AA,$85,$43,$42,$40,$8A,$C5,
  $43,$42,$40,$8A,$C5,$43,$42,$43,$C0,
  $65,$65,$65,$EA,$C5,$43,$42,$40,$8A,
  $C5,$43,$42,$40,$8A,$C5,$43,$42,$43,$80)
  goto main
```

Listing 7
```
main:
  readtemp 4,b1
  debug b1
  pause 100
  goto main
```

Listing 8
```
main:
  readtemp 4,b1
  if b1 > 25 then too_hot
  if b1 < 15 then too_cold

temp_ok:
  low 0
  high 1
  low 2
  goto main

too_hot:
  high 0
  low 1
  low 2
  goto main

too_cold:
  low 0
  low 1
  high 2
  goto main
```

from the on-board circuits by moving position 4 of the 4-way switch (SW2) to the "off" position (leave all other contacts in the "on" position for now).

The program in Listing 7 is almost the same as the LDR test program from last month, except that we're using the **readtemp** command here instead of **readadc**. The **readtemp** command reads the temperature value from the DS18B20 sensor, which is then displayed on the computer screen with the aid of the **debug** command.

The final program this month (Listing 8) demonstrates how your system can act as "cold-warm-hot" indicator, using only the DS18B20 temperature sensor and the three on-board LEDs.

Task – write a program that plays a musical tune when the temperature drops below 20°C.

Next month

Next time around, we'll look at controlling devices that move. Motors, servos and solenoids are all on the menu, so start looking through that junk box for motors to salvage! **SC**

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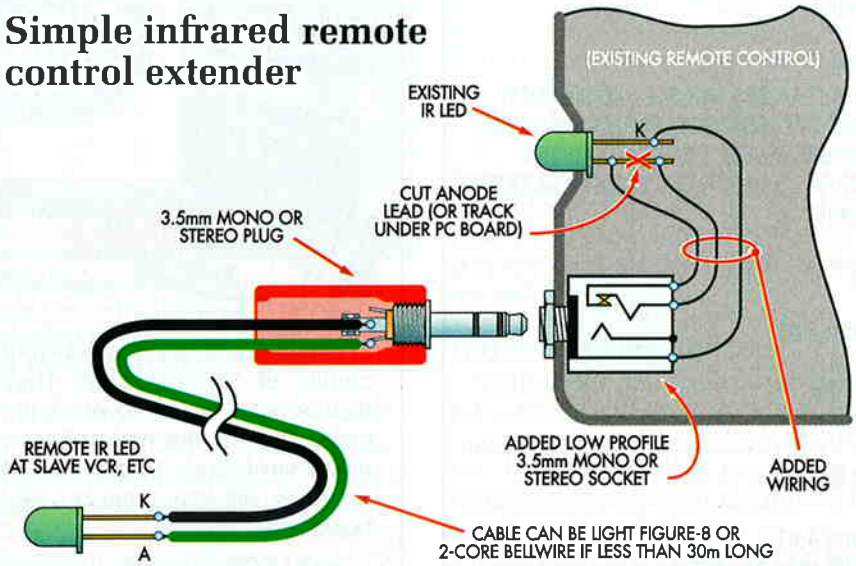
CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

Simple infrared remote control extender


(EXISTING REMOTE CONTROL)
EXISTING IR LED
K
CUT ANODE LEAD (OR TRACK UNDER PC BOARD)
3.5mm MONO OR STEREO PLUG
REMOTE IR LED AT SLAVE VCR, ETC
K
A
ADDED LOW PROFILE 3.5mm MONO OR STEREO SOCKET
ADDED WIRING
CABLE CAN BE LIGHT FIGURE-8 OR 2-CORE BELLWIRE IF LESS THAN 30m LONG

This ultra-simple remote control extender is ideal for use with a hidden video recorder. The recorder is a Panasonic NV-SD200 and is used as part of a camera surveillance system. A PICAXE-08-based circuit is used to detect events and control the recorder. It also flashes a LED near the monitor to indicate the number of events since last viewing.

Strangely, the NV-SD200 model refused to work with a number of commercial infrared remote control extenders, hence the need for this design. As a bonus, it uses less power than a traditional extender (no plugpacks) and the remote can still be used in the normal manner.

As shown, an additional 5mm infrared LED is mounted directly in front of the equipment to be controlled. This is cabled back to a convenient location near the monitor and terminated in a 3.5mm plug.

To modify the remote control unit, break the circuit to the anode of the existing infrared LED and wire in a 3.5mm headphone socket. In most cases, the LED will be accessible without dismantling the circuit board. The purpose of the socket is to allow the existing infrared LED to operate normally when the jack is unplugged.

If the socket won't fit inside the case, then a very short flying lead with a moulded in-line socket can be used instead. By using light-duty figure-eight cable, the transmitting LED could be 30m or more from the hand-held remote control without problems.

Ron Russo,
Kirwan, Qld.

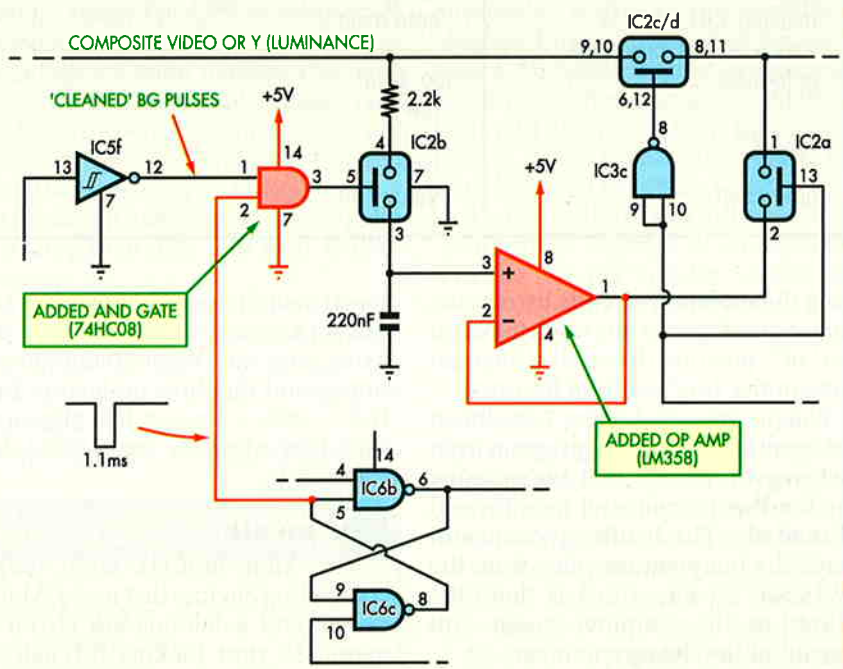
Improved stability for Dr Video

The Dr Video Mk 2 video stabiliser (SILICON CHIP, June 2004) works well but in my application, there was a problem with the clamping level during blanking. A "kick" in the level across each field was noticed, as well as a slight slope under each video line.

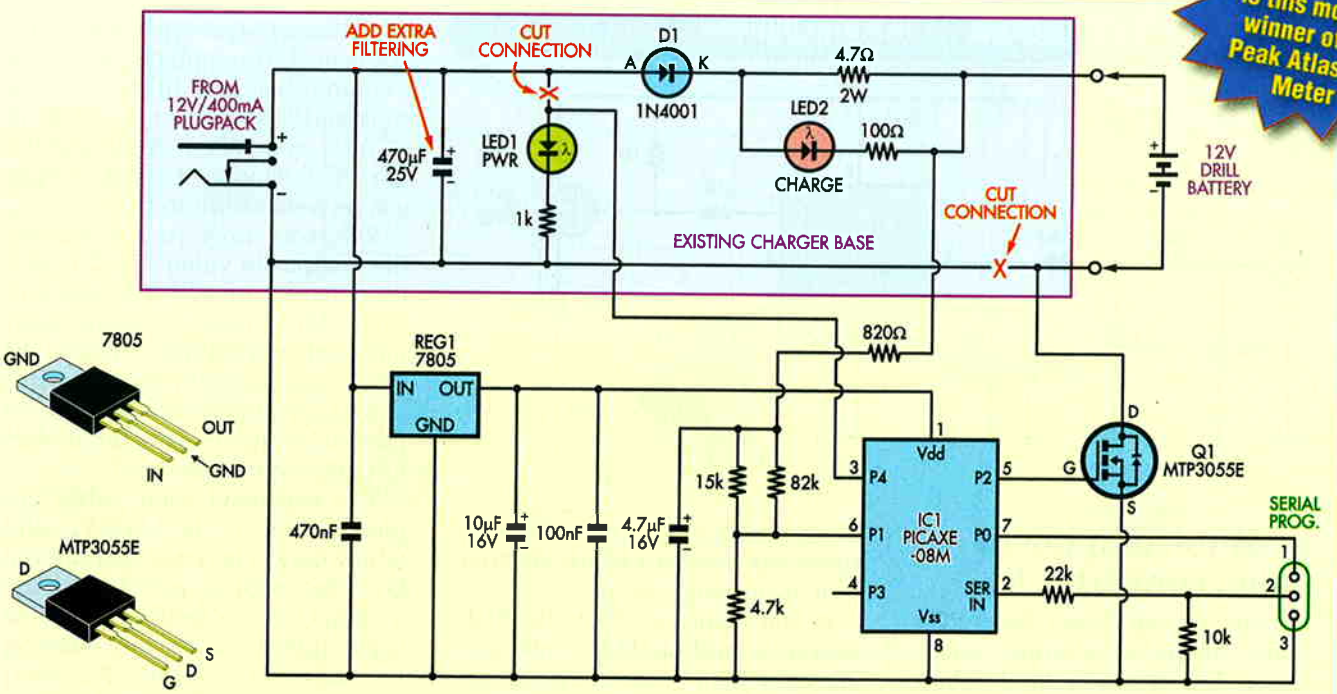
It appeared that sampling (via IC2b) was occurring at times in the vertical blanking period when the black level was not "clean". This was fixed by adding an AND gate and op amp for signal buffering, as shown. The extra parts can be mounted on prototyping board and should include a 100nF decoupling capacitor between +5V and ground.

Any unused logic and op amp inputs should be tied to ground.

Nick Graham,
Sydney, NSW.



Clive Allan is this month's winner of the Peak Atlas LCR Meter



Cordless drill auto-charger

The ridiculously low price of battery-powered drills means that like myself, many readers will have been tempted to buy one or more for the toolbox. The recently advertised price of $17.99 for some 12V models is less than the retail price of the NiCd batteries alone!

A series resistor is all that's used to limit output current in the charger base supplied with these models. This works OK if you remember to turn the unit off once the batteries are fully charged (after about five hours) but it's too easy to forget this important step.

It's possible to considerably improve the function of the charging circuit for little cost, eliminating the need to switch off the unit and extending battery life. This can be achieved by modifying the original charger base and adding a PICAXE-based control circuit, as shown in the above circuit diagram.

The circuit can be constructed on a small section of prototyping board and installed inside the charger housing. Modifications to the existing circuit are limited to adding a 470µF filter capacitor across the plugpack input rails and breaking the circuit to the negative battery contact and the anode of the LED. Light-duty hook-up wire is then used to connect the two sections together, as shown.

The PICAXE microcontroller (IC1) controls the charging by switching the negative side of the battery pack with a logic-level Mosfet (Q1). It also drives the existing "power" LED to indicate battery status.

An analog-to-digital input (ADC1) of the PICAXE is used to sample the battery voltage via a resistive attenuator and RC filter. The result from the **readadc** command allows the program to roughly determine the charge state of the pack. A flat battery pack results in the maximum 4-hour charge, whereas intermediate terminal voltages result in either a 1-hour or 2-hour charge.

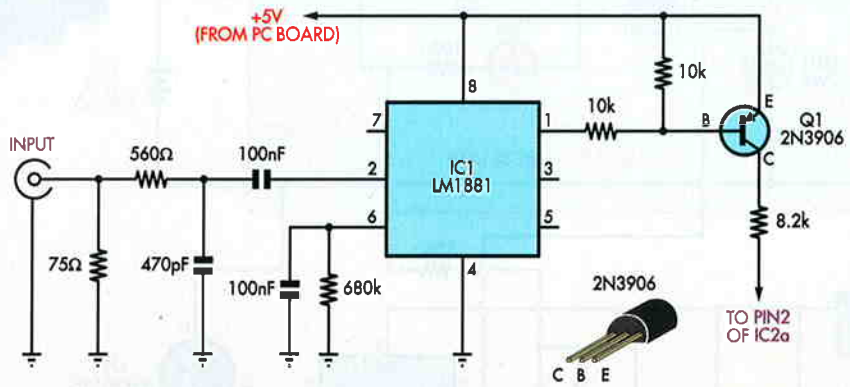
When a battery pack is inserted, the LED is flashed for the number of hours that it will be charged. Once charging is complete, the Mosfet is pulsed only briefly at several second intervals and the ADC input read.

The result is used to detect when the pack is removed, allowing the software to reset itself for the next charge cycle. Note: due to space constraints, we're unable to reproduce the PICAXE BASIC program for the charger here, but it can be downloaded free from **www.siliconchip.com.au**.

Clive Allan,
Glen Waverley, Vic.

CONTRIBUTE AND WIN!

As you can see, we pay good money for each of the "Circuit Notebook" contributions published in SILICON CHIP. But there's an even better reason to send in your circuit idea: each month, the best contribution published will win a superb Peak Atlas LCR Meter valued at $195.00. So don't keep that brilliant circuit secret any more: sketch it out, write a brief description and send it to SILICON CHIP and you could be a winner!



RGB-to-component video converter fix

Some set-top boxes have RGB video outputs, whereas widescreen TVs typically have colour difference (Y, Cr and Cb) inputs. The "RGB-to-Component Video Converter" (SILICON CHIP, October 2004) provides a simple solution to this problem.

I constructed the converter from a kit of parts but could not get it to produce a picture on my TV. Examination of the three colour difference signals with an oscilloscope revealed that none had the necessary sync pulses that should occur during the blanking intervals. This explained the lack of a picture, as some sets present a blank screen if sync is missing.

It was expected that the RGB source would include "sync-on-green", which in the converter circuit would propagate through to the Y (luminance) output for use in the TV. Two popular set-top boxes were tried, but neither provides the sync-on-green function. However, they do have composite video outputs. This little add-on circuit extracts the sync pulses from the composite signal and adds them to the Y output to correct this deficiency.

A fourth RCA input socket can be added to the front panel of the converter to accept the composite signal from the set-top box (or other appliance). The appliance may have a composite output in the form of a separate RCA socket or as part of the SCART connector. Alternatively, the "Y" channel of a Y/C output can be used as the source.

Referring now to the circuit, the composite video signal is first terminated with a 75Ω resistor and excessive chroma or noise is attenuated with a simple low-pass RC filter, formed by the 560Ω resistor and 470pF capacitor. The signal is then AC-coupled to the input of an LM1881 sync separator IC.

The separated sync pulses appear on pin 1 of the LM1881, after which they're inverted by transistor Q1. The result is injected into the Y signal path by feeding it into the input (pin 1) of op amp IC2a on the converter PC board. An 8.2kΩ series resistor effectively sets the sync level at about 0.3V.

The circuit was built on a small piece of Veroboard (approx. 20 x 40mm) and attached to a vacant area of the PC board with double-sided tape. The project works very well and achieves the desired results, improving resolution and eliminating "crawling" around the edges of high-chroma pictures.

Graham Bowman,
Duncraig, WA.

Transistor makes high-power zener

High-power zener diodes are expensive and hard to find, particularly above the 10W level. In certain applications, a power transistor can be used as a substitute.

The base-emitter junction of an ordinary transistor acts like a zener diode when operated in reverse bias. The actual breakdown voltage varies according to the type of transistor and manufacturer.

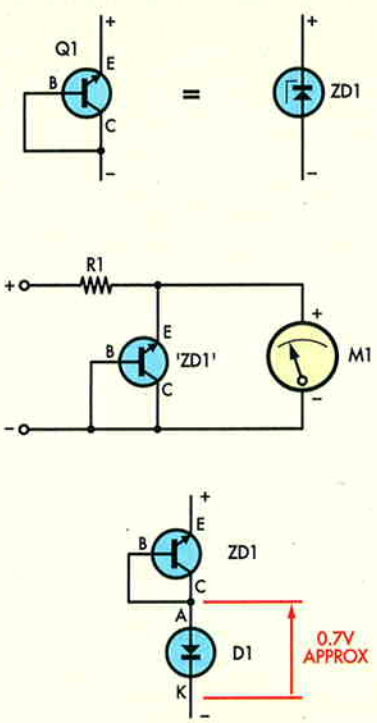
To obtain a specific reference voltage, a simple test circuit can be constructed as shown in the diagram at right, using a series resistor of about 1kΩ and a 15V DC supply. Suitably rated silicon diodes can be added in series with the "zener" to increase the overall breakdown voltage, with each diode adding about 0.7V.

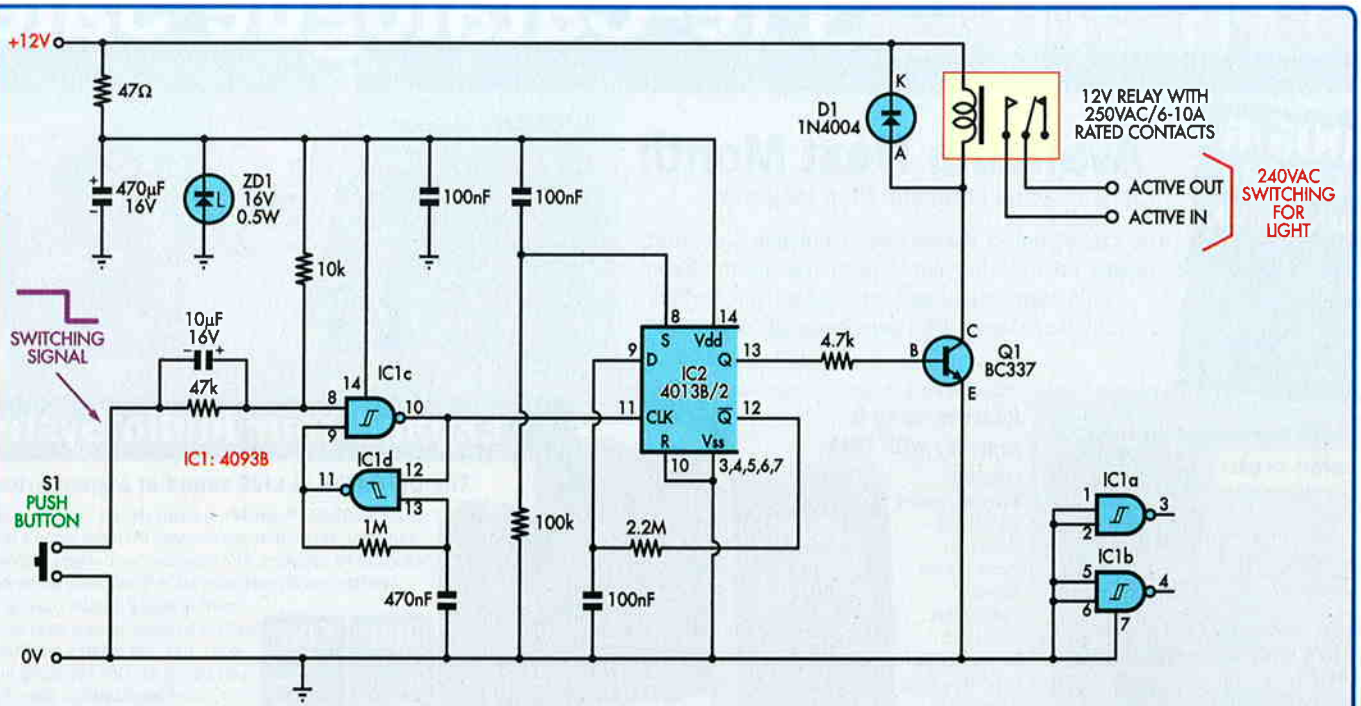
A Motorola TIP31C transistor was found to have a reverse breakdown of about 9.0V, whereas for a Motorola 2N3055, breakdown was somewhat higher at 11.6V.

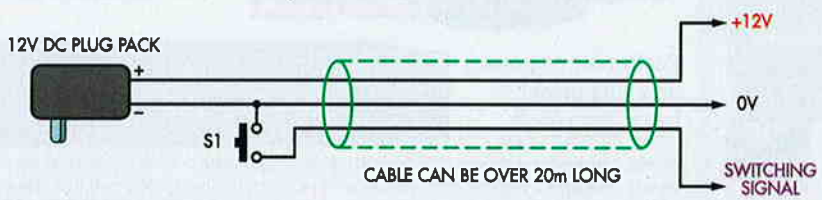
Editors note: transistors could conceivably make very simple, high-power shunt references. However, unlike zener diodes, their P-N junctions are generally not designed to conduct current "evenly" when in avalanche mode.

In other words, it's impossible to know what the maximum safe level of reverse current would be for a particular device.

Michael Ong,
City Beach, WA.







Low-voltage remote mains switch

This circuit allows a 240V mains appliance to be controlled remotely via low-voltage cabling and a push-button switch.

The mains appliance (in this case, a light bulb) is switched with a suitably-rated relay. All of the electronics is housed in an ABS box located in proximity to the appliance. The pushbutton switch and plugpack are located remotely and can be wired up with 3-core alarm cable or similar. Cable lengths of 20m or more are feasible with this arrangement.

When the switch (S1) is pressed, the input (pin 8) of IC1c is briefly pulled low via the 10µF capacitor, which is initially discharged. The output (pin 10) immediately goes high and this is inverted and fed back to the second input (pin 9) via another gate in the quad NAND package (IC1d). In conjunction with the 1MΩ resistor and 470nF capacitor, IC1d eliminates the effects of contact "bounce" by ensuring that IC1c's output remains high for a predetermined period.

The output from IC1c drives the clock input of a 4013 D-type flipflop (IC2). The flipflop is wired for a "toggle" function by virtue of the Q-bar connection back to the D input. A 2.2MΩ resistor and 100nF capacitor improve circuit noise immunity. Each time the switch is pressed, the flipflop output (pin 13) toggles, switching the transistor (Q1) and relay on or off.

Note that all mains wiring must be properly installed and completely insulated so that there is no possibility of it contacting the low-voltage side of the circuit.

Bob Hammond,
Engadine, NSW.

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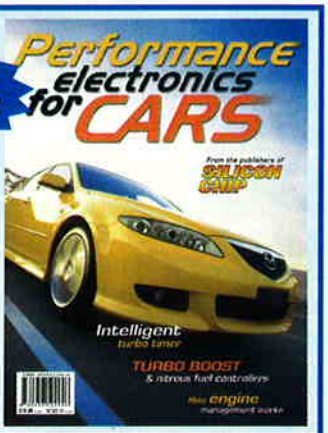

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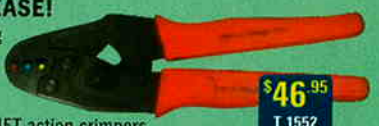

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(18)

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- 140W RMS into 8Ω
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$199 K 5173 RRP $299.95

Remote control volume kit

(SC June '02) Can be built into just about any audio project, such as amplifiers, pre-amps etc. Add a touch of class to your home made audio gear! A 1013 remote to suit $32.

$30 K 5026 RRP $39.95

Subwoofer Controller Kit:

ADD SERIOUS BASS TO YOUR HI-FI

(SC Dec '95) Designed by Altronics! Combine it with a 10 or 12 inch subwoofer and its bound to Impress your mates. A subwoofer module with loads of features: • Adjustable frequency crossover • Volume control • Preamp • Phase shifter • Suits bridged or single channel amps • Requires 12V AC supply (M 9265 $15.95)

$30 K 5562 RRP $39.95

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SAVE OVER 30%

(SC Feb '01) Displays 4 VU level meters ranging between 32Hz to 160Hz. Perfect for seeing what your subwoofer really gets down to!

$33 K 5410 RRP $39.95

Sub Bass Extender Kit

$12.95 K 5561 NEW

AMAZING VALUE!

(SC April 2005) Can provide nearly an extra octave of bass response from your existing hi-fi speakers. Suitable for sealed and vented enclosures it is sure to supply an added boost to your hi-fi or home theatre. Supplied with a blank jiffy box case.

25W Amplifier Module

(SC Dec 93) Great low cost test amplifier! Very easy to assemble. Ideal introduction to audio circuits for students or beginners. Delivers 25W RMS into 4Ω. Includes heatsink. Power supply available seperately.

$16 K 5113 RRP $21.95

Headphone Amplifier

$12 K 5506 RRP $14.95

(SC May 02) A simple and effective line level booster for raising headphone volume without a noticeable increase in distortion. Max 90mW @ 8Ω.

Jam along to your favourite songs!

(SC October 00) Play along with your favourite songs, through your headphones or stereo. Great way to learn & perfect new riffs. Easy to build and use.

$22 K 5536 RRP $27.95

$14.95 K 1102 NEW!

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(SC May '02) Incredibly easy to build, this cool LED chaser has 32 super-bright red LED's that can light up in 12 different patterns. Powered by 12V DC.

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(SC June 2003) Allows you to run equipment in your car which requires more than the 12V your car battery can supply. Adjustable from 13.8-24V @ maximum of 2A.

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(SC June '03) Automatically switch on/off equipment at dusk/dawn. Great for those who want to run garden lights or even to automate lighting when you go on holiday to fool burglars!

$50 K 6025 RRP $64.95

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Altronics' new 250W Aussie-made PA Amp

A few months ago, Altronics were pretty excited about their brand new 250W PA "Redback Phase 4" mixer/amplifiers and wanted us to have a look at one. In fact, it was so new that we had to wait some time for it . . .

We anxiously awaited its delivery because we had a major sporting event coming up where we could give it a "baptism of fire" evaluation against equipment we knew and trusted.

As Murphy's law always has it, the amplifier (Altronics told us it was the first one off the production line) didn't quite make it in time (it arrived just two days after the event – of course!) so, while we were able to give it a preliminary check-out, we couldn't easily give it a real-life run until recently.

Testing a high power PA amplifier is normally not quite as simple as testing a stereo amplifier or similar. Amplifiers are normally tested in two parts – on-bench testing using dummy loads to see if they meet manufacturer's specifications, then evaluation by ear using high performance, known speakers to see how they sound.

Review by Ross Tester

True PA amplifiers have an extra "wrinkle"– they're normally designed to work into 100V (or 70V) lines. This is to minimise I^2R losses over long speaker lines.

Our dummy load setup was never really intended to cater for 100V-line amplifier measurement.

100V lines

Maybe some explanation is needed. PA Amplifiers almost always use a transformer to step up their output to a nominal 100V level (some older ones are 70V). This is fed into the lines going off to the speakers, which themselves have another transformer to step the voltage back down again.

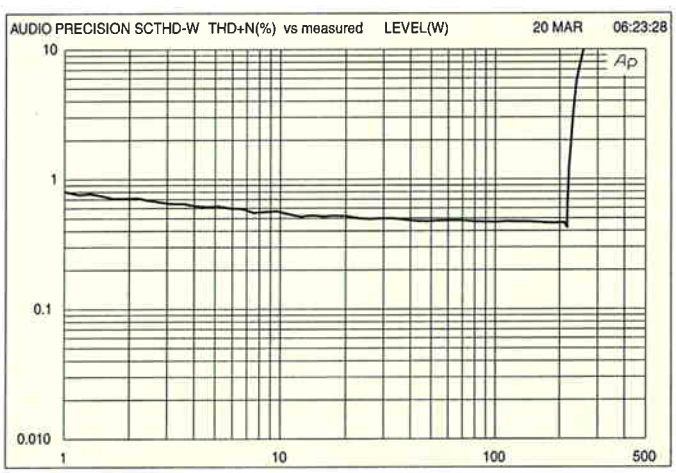
This results in a much lower line current to the speakers. As line losses are a square of the current times the line resistance and, by definition, long speaker lines are a feature of most PA installations (each with perhaps several ohms resistance), this can make a very significant difference, especially at high power levels.

The other advantage of running "100V lines" is that all the problems of speaker impedance matching blissfully disappear!

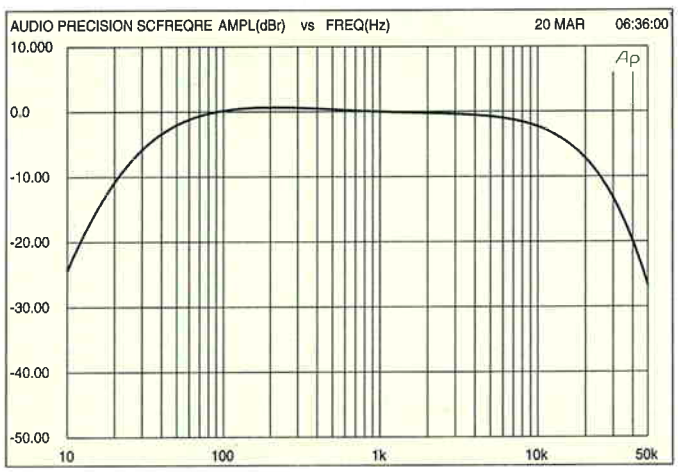
Instead of worrying about speaker combinations in series and parallel to keep to a (say) nominal 8Ω at the amplifier, all 100V line speakers are run in parallel – all you need do is add up the power ratings of all the speakers in the system and ensure the total is kept at or under the power rating of the amplifier.

So if you have a situation requiring a couple of 35W speakers, four more 25W speakers and eight 10W speakers, you simply run them all in parallel on your 250W amplifier.

Need to add a couple more speakers to fill in some "sound holes"? Most PA speakers have selectable power



Power output into a 4Ω load. It didn't quite make the 250W mark but the difference is too small to be noticed.



Claimed frequency response is 50Hz-12kHz (-3dB) and this test shows that's just about spot on!

The front of the amplifier has a clean, uncluttered layout – though we did find the "up and down" positioning of the level controls took a bit of getting used to (we're more used to a straight horizontal layout as per a multi-channel mixer). The LED indicators, bargraph included, all make life easy when you're busy programming an event!

tappings so if you need to, you can reduce the power of one or several speakers as required to keep that total under the 250W figure.

Having said all that, the new Altronic Redback Phase4 PA amplifier can be run into 100V, 70V or low impedance (4-16W) loads. So it is one very flexible amplifier. Note that we said "or" – you cannot run combinations of loads (eg 100V and 8Ω) at the same time.

So it turns out we could check the amplifier using our bench testing setup and the low impedance outputs. But in-the-field testing would have to wait until another opportunity arose where a 100V line system was in use.

Recently, that opportunity did arise – and this is the result!

Specifications

Power output: ..... 250W RMS
Distortion: ..... <0.5% @ 1kHz
Speaker output: ..70V, 100V or 4 - 16Ω
Line output: ..... 600Ω balanced, 0dBV
Frequency response:
Mic inputs: ..... 50Hz -12kHz, -3dB
Aux inputs: ..... 50Hz -15kHz, -3dB
Input Sensitivity:
Mic inputs: ..... 3mV balanced
Aux inputs: ..... 100mV & 1V
Signal to noise ratio (limiting bypassed):
Mic inputs: .. >75dB below rated output
Aux inputs: .. >81dB below rated output
Tone controls:
Bass: ..... ±10dB @ 100Hz
Treble: ..... ±10dB @ 10kHz

Appearance

The Redback Phase4 250W PA Amplifier is housed in a black, 2U rack-mounting cases. Overall dimensions are 483w x 330d x 88h and it weighs in at a fairly hefty 19.5kg. Having two big transformers (a power transformer and 100/70V line output transformer), at least partly explains this.

Level controls for the six inputs, a master level control and separate bass/treble controls are all on the left side of the front panel. While clearly labelled, we found the vertical arrangement of controls at least somewhat confusing, being used to channel-1 to channel-x arranged left to right. But that's something you could get used to.

On the right side of the front panel are several LED indicators, used to show an input signal, signal overload, signal peak, excess temperature and power. There's also a LED bargraph VU meter showing program level from -24dB through 0dB to +3dB, the final LEDs being yellow and red respectively to show overload.

A whopping big power switch and Redback/Phase4 logo round out the centre of the front panel, with airflow slots on the left and right sides and of course the rack-mounting flanges with their handles.

Just try picking the amplifier up from the horizontal using the handles . . . if you can, you're a stronger man than I, Gunga Din! (with humble apologies to Rudyard Kipling).

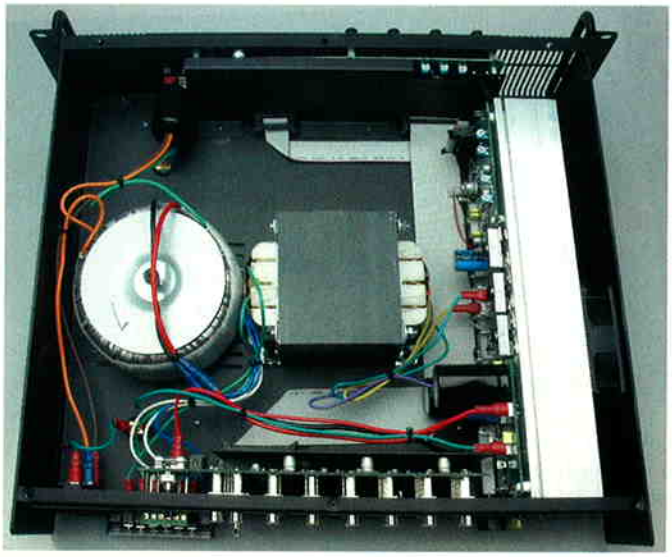
The back panel

Here's where all of the inputs and outputs are located along with controls to set the amplifier up the way you want it.

Each of the input channels can be configured for microphone (3-pin XLR) or line (2x RCA) via its own 4-way DIP switch. The other switches in the DIP set select line input sensitivity (100mV or 1V), VOX priority (for inputs 1-3) and whether phantom power is on or off.

As the above implies, with an optional board, channels

Here's the business end of the amplifier – the inputs and outputs. Each of the DIP switches change various input functions. They're a tad tiny for fat fingers but most users would set them once and forget them. At lower left are the three different outputs (100V, 70V and low impedance); above that connections for remote volume control, PTT and switched 24V DC.



Inside the beast, looking from back to front. Dominant are the power (left) and output (centre) transformers. Interestingly, the output transformer is not a toroidal type. The fan-cooled heatsink is clearly visible at the right of this photo.

1-3 can also operate in VOX mode (voice operated switch), meaning that the amplifier outputs when there is an input signal. Another option is an internal alert/evacuation tone/siren board, which when activated takes priority for emergency use.

To be picky, I found the dip switches fiddly with my fat fingers but this is hardly a criticism of note because in most installations, the amplifier would be "set and forget". It's only people like me who want to move an amplifier between various events who might find this a problem.

Also on the back panel are the output terminals: 100V line, 70V line and low impedance (4-16Ω), all screw terminals protected by a clip-on plastic cover which I proceeded to lose within a few minutes (sorry, Mr Altronics).

As well as another XLR connector offering preamp output there is also a pre-out/main-in provision so you can add effects if you wish. Another DIP switch allows the preamp output to be pre- or post- the master volume control. A pair of RCA terminals also gives a tape output.

The amplifier is normally powered from the mains (via an IEC cable, supplied) but can be powered from 24V DC when in a portable situation, or an emergency application if the mains fails. There is even inbuilt provision for keeping a 24V battery trickle charged (300mA).

Finally, one other handy option is provision for a remote volume control – a standard 500Ω pot can be wired into the system via ordinary figure-8 (ie, unshielded) cable to give volume control up to 100m away from the amplifier. A pair of screw terminals on the back make this simple.

In use

I tested the amplifier using both microphone and line level inputs, the latter with a variety of program material ranging from tape and CD players through to a portable MP3 player. I also tested both 100V line and low impedance outputs.

I was very impressed with the "crispness" of the output, even when the wick was well and truly wound up. (To anyone on the northern beaches who wondered where that very loud Beach Boys music was coming from on the long weekend, sorry . . .)

This amplifier compared more than favourably with another 250W brand I regularly use. Distortion, by the way, is quoted at <0.5% @ 1kHz – that's pretty good for a PA amp. . . actually it's very good!

I have collected quite a variety of microphones over the years – some good, some oh well and as you might imagine they have sensitivities all over the place. However, all performed as expected on the microphone inputs (3mV sensitivity). The better microphones sounded very good indeed.

Signal to noise ratio is better than 75dB below rated output on microphone and 81dB on line inputs.

Using PA horns it was difficult to judge the adequacy of the bass control – no matter how much boost you apply you cannot get much bass out of those babies – but the treble control certainly showed there was plenty of boost and cut available. Claimed control for both is ±10dB.

By the way, this was never intended to be a hifi amplifier – it is a PA amplifier. So the frequency response of 50Hz-12kHz (-3dB) might not appear to be too spectacular in these days of DC to daylight – but for its intended use, it's more than adequate.

In fact, too low a frequency response in a PA amp is an invitation for hum and other noises to rear their ugly heads.

There are several levels of protection built in. First of all there is automatic output limiting, preventing the voltage exceeding 110V at any time to prevent damage to speakers.

There is also overload protection, reducing the output current (instead of blowing a fuse, which my other amplifiers tend to do – always at the worst possible moment). A front panel LED flashes to warn of the problem.

There is of course fuse protection on both the AC and DC circuits but these are a "worst case" scenario, protecting the amplifier when the other methods have failed.

The amplifier is also fan-cooled, the fans automatically switching in as required.

Price, availability

The Redback Phase4 250W PA Amplifier (Cat A4085) is available from Altronic Distributors, 174 Roe Street Perth WA 6000 (PO Box 8350 Perth Business Centre WA 6849). Phone (08) 9428 2188.

It has a recommended retail price of $1065, which compares well to imported amplifiers of similar capability.

There is a 125W version available (Cat A4075) which sells for $875. It looks pretty much identical but is about 5kg lighter. The warranty on both systems was five years but in the last few days has been increased to a whopping ***ten*** years. We've never heard of anything better!

Recommended?

Now we know what Altronics were getting excited about! If you need a high power PA you'd go a long way to better this one.

Most users would rate our few criticisms as nit-picking; it performed flawlessy and did everything we asked of it.

The fact that it is designed and assembled in Australia is a bonus! **SC**

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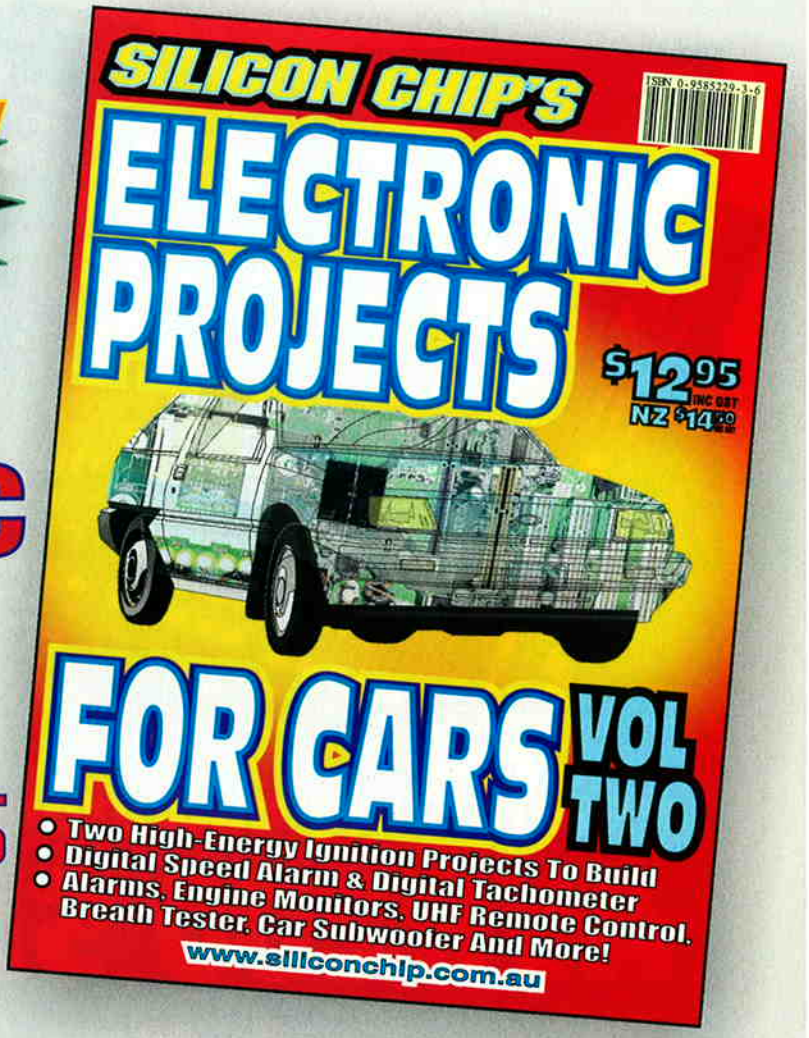
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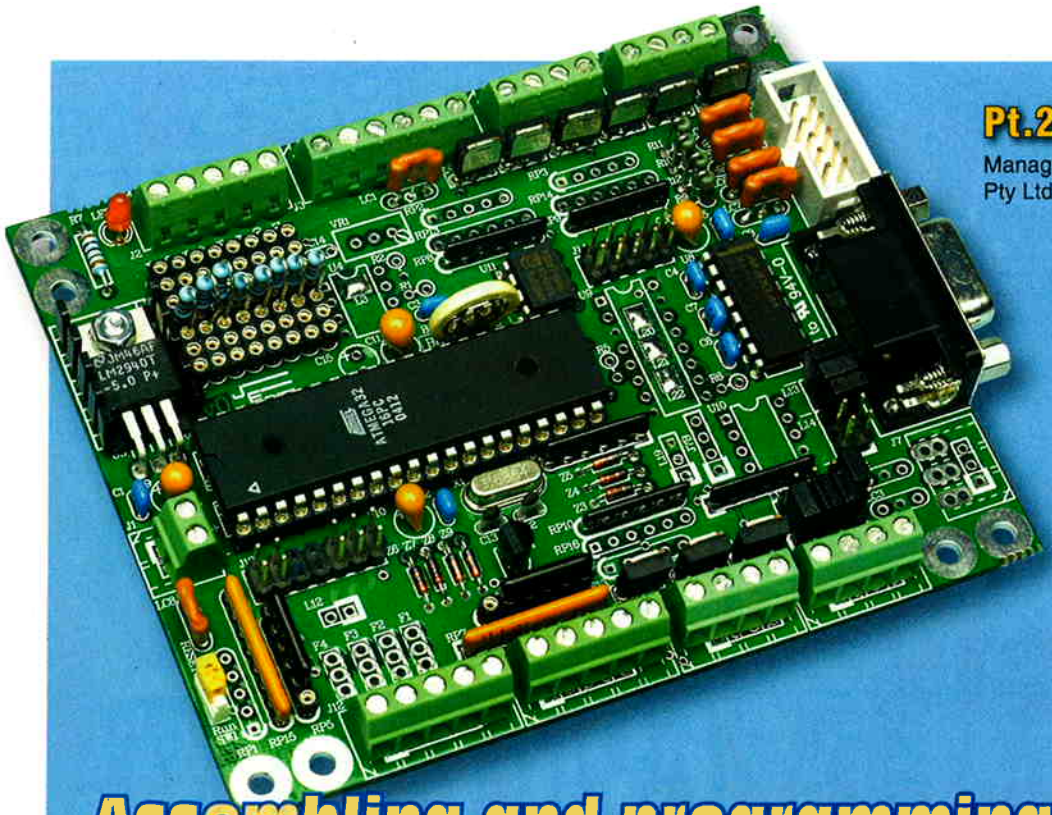


Pt.2: By ED SCHOELL*

Managing Director, JED Microprocessors Pty Ltd.

Assembling and programming the AVR200 Single Board Computer

Last month, we published the circuit details for JED Micro's new low-cost ATmega32 development board and described the various I/O options. This month, we show you how to assemble it and go on to describe several popular software development and programming options.

ASSEMBLY OF THE AVR200 is quite straightforward as the PC board is a plated-through, double-sided design with solder resist on both sides. To reduce component count and simplify construction, most resistors are contained in single-in-line (SIL) arrays.

In its standard configuration, the board provides eight analog inputs or digital inputs/outputs, 11 digital inputs and nine Mosfet outputs. Also included are a real-time clock, buffered I²C port and RS232 serial port.

If the standard port I/O arrangements are not suitable for your application, then most port lines can be swapped from inputs to outputs or vice versa with only minor component changes. It is therefore important to examine the various options carefully before starting assembly, to ensure that the correct parts are installed from the outset.

We covered the various options in detail last month. In summary, the kit contains all of the components needed to configure all available port lines (28) as inputs, if desired. Eight of these can be either analog or digital inputs, with the remainder being digital only.

Note that the remaining four port bits of the ATmega32 are dedicated to the I²C and RS232 serial interfaces.

Conversely, if more than the standard nine port lines are required as outputs, then up to 12 additional Mosfets can be installed for a full complement

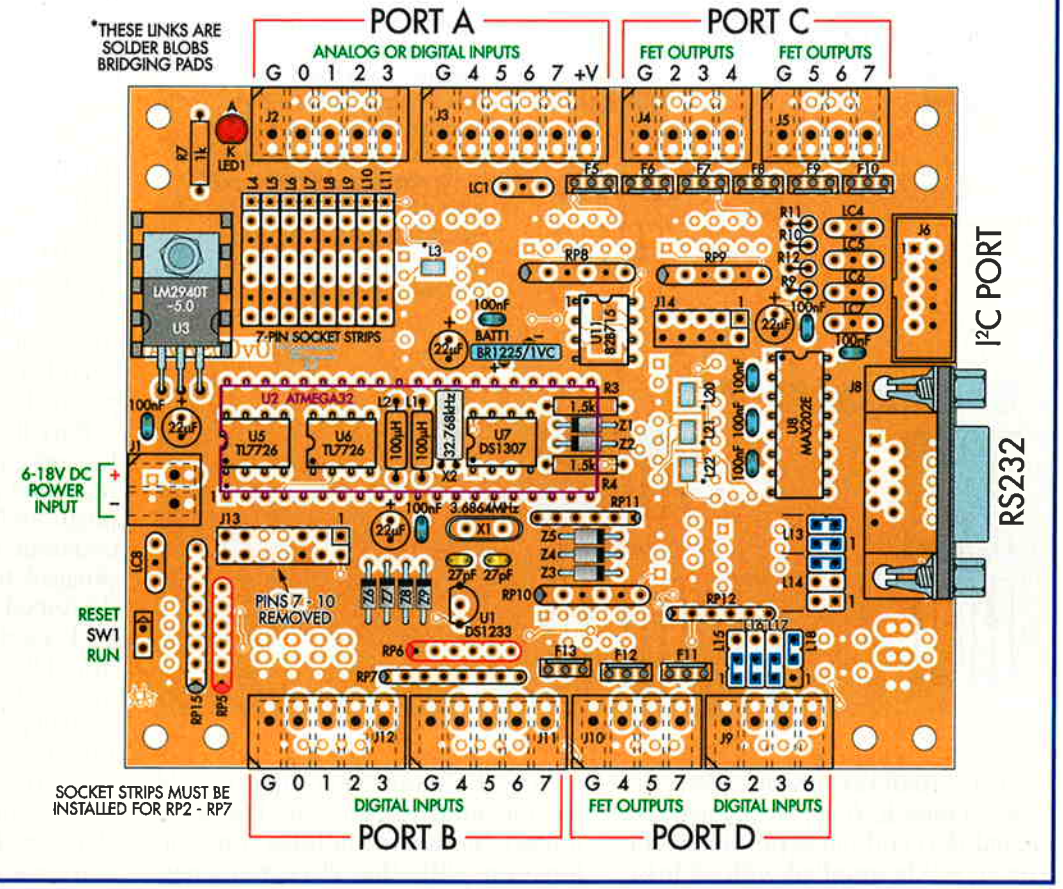


Fig.5: use this diagram as an aid when assembling your board. Socket strips are needed for resistor packs RP2-RP7, with all others being soldered directly into the board. Of the six packs, only RP5 & RP6 are installed in the standard configuration shown here. To install optional items, follow the silkscreen overlay printed on the board and the instructions in the text.

of 21 outputs (still giving seven digital inputs). The extra Mosfets are not included in the basic kit but can be ordered separately from JED.

Preliminaries

To help make construction easier, we've organised our description into logical steps, first assembling the components common to all configurations. We then separately describe the assembly of the components needed for each port (A-D) in turn, with the standard configuration shown first and the optional configuration (if any) immediately after.

We recommend that you map out your desired I/O port configurations, including requirements for any additional features (eg, RS485 port and high-resolution voltage reference) and read the entire assembly instructions before commencing construction.

Power supply

The power supply section should be assembled and tested first. Begin by installing the LM2940T voltage regulator (U3). It mounts horizontally on the board, so first bend its leads at 90° about 6mm from the body and trial fit it into position to ensure that the hole in the tab lines up with the large hole in the PC board. Adjust the lead bend as necessary, then position the TO-220 heatsink between the regulator and the PC board (see photos). Finally, fasten the assembly in place using an M3 screw, nut & flat washer before soldering and trimming the regulator's leads.

All other components related to the 5V power supply should now be installed. These are the 2-way terminal block (J1), DSS706 filters (LC1, LC4-LC8), all 100nF monolithic capacitors and the four 33µF tantalum capacitors. Note that the positive leads of the tantalum capacitors must go in as indicated on the overlay diagram, otherwise they'll be destroyed in a flash at power on! The power indicator circuit, consisting of the LED and 1kΩ resistor (R7), can also go in now.

Now connect a 6-18V DC power source to the input terminals on J1 (note polarity) and power up. Check for correct operation of the power supply by measuring the voltage between the ground and output terminals of the regulator (U3). You should get a reading of between 4.75V and 5.25V. Note also that the LED power indicator should light.

Common assembly

Rather than a conventional 40-pin socket, the ATmega32 (U2) is mounted in two 20-pin socket strips. As with all other headers and socket strips used in this project, these must be cut down from the longer sections supplied in the kit. This is done using a sharp utility knife or a pair of side-cutters.

When installing the socket strips, make sure that they're seated all the way down on the PC board and at right angles to it before soldering. Once that's done, install all of the components that go underneath the microcontroller. This includes the TL7726 hex clamp ICs (U5 & U6), the real-time clock IC (U7), 32kHz crystal (X2) and 100µH inductors (L1 & L2).

As usual, take care with the orientation of the ICs and zener diodes. Note that U5, U6 & U7 must be soldered directly into the board. Don't use IC sockets, because it will not be possible to fully insert U2 later on.

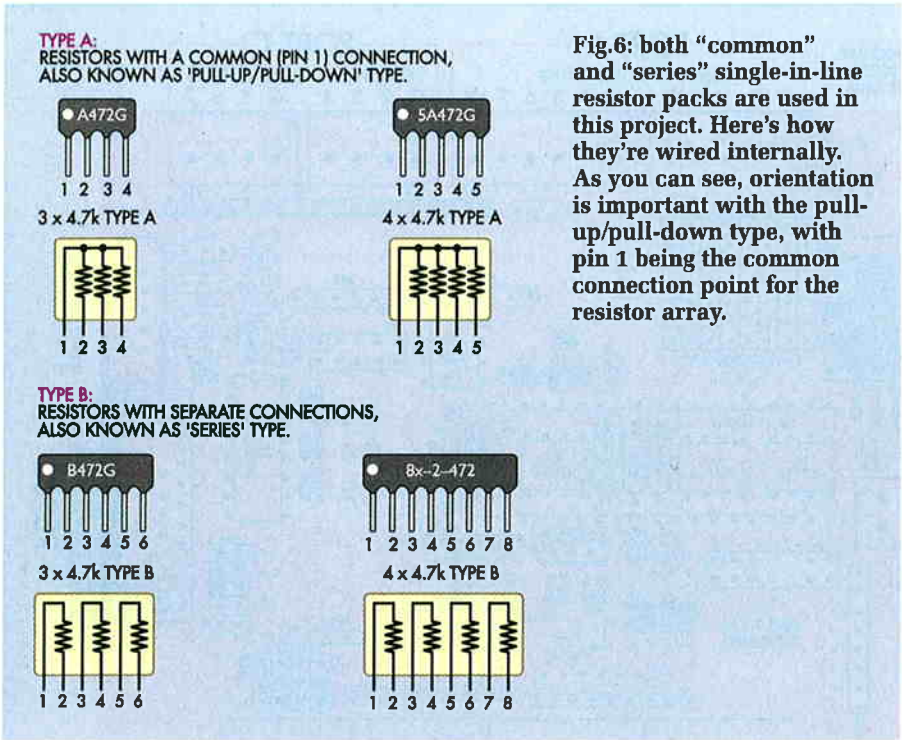

TYPE A:
RESISTORS WITH A COMMON (PIN 1) CONNECTION, ALSO KNOWN AS 'PULL-UP/PULL-DOWN' TYPE.
A472G
1 2 3 4
3 x 4.7k TYPE A
1 2 3 4
5A472G
1 2 3 4 5
4 x 4.7k TYPE A
1 2 3 4 5
TYPE B:
RESISTORS WITH SEPARATE CONNECTIONS, ALSO KNOWN AS 'SERIES' TYPE.
B472G
1 2 3 4 5 6
3 x 4.7k TYPE B
1 2 3 4 5 6
8x-2-472
1 2 3 4 5 6 7 8
4 x 4.7k TYPE B
1 2 3 4 5 6 7 8

Fig.6: both "common" and "series" single-in-line resistor packs are used in this project. Here's how they're wired internally. As you can see, orientation is important with the pull-up/pull-down type, with pin 1 being the common connection point for the resistor array.

Next, install reset switch SW1, the DS1233 reset IC (U1), the 3.6864MHz crystal (X1) and the 27pF capacitors. The crystal is supplied with an insulating washer that fits over its leads to isolate the underside of the package from the PC board. Make sure that this is in place during installation.

Note also that the "arrow" on the top of the reset switch should point towards the "RESET" marking on the overlay.

To complete the common part of the assembly, install all of the connectors and headers, including the screw-terminal blocks (J2-J5 & J9-J12), the D9 connector (J8), I^2C headers (J6 & J14), SPI header (J13), and links L13-L18, with attention to the following:

Before installing J13, cut pins 7-10 off flush with the plastic carrier using side-cutters or pull them out with a pair of pliers (see Fig.5). Note that J13, J14, L13 and L14 are cut down from longer dual-row header strips, whereas links L15-L18 are cut down from single-row strips.

Port A – analog/digital inputs (standard): install eight 7-pin socket strips in locations L4-L11. Again, these are cut down from the longer strips supplied in the kit.

Various components are plugged into the strips to perform basic signal conditioning functions ahead of the port inputs, as described in Pt.1.

At a minimum, each input should have a series resistor (see Fig.4a) to protect the microcontroller (in conjunction with the TL7726 voltage clamps). Eight 10kΩ resistors are provided in the kit for this purpose.

Port A – digital outputs (optional): the socket strips (L4-L11) are also installed if you wish to use port A as low-current digital outputs. In this case, a small resistor (about 100Ω) should be inserted in series with each output (see Fig.4a).

The socket strips **must not** be installed if you want to use port A as high-current Mosfet outputs. Instead, the Mosfets and their 10kΩ gate pull-down resistors (R_{pd}) are soldered directly into the PC board in place of the socket strips (see Fig.4f).

Note that the Mosfets are not supplied in the kit but can be ordered separately from JED, part number MTD3055VL.

Important: while it is possible to mix digital inputs and outputs on port A, it is not recommended to mix analog inputs and digital outputs, as noise from the outputs may cause inaccuracies in analog readings.

Analog reference (standard): if the +5V (V_{cc}) supply is to be used as a voltage reference, link L3 must be shorted by "blobbing" it with solder. Conversely, if the internal +2.56V band-gap reference is to be used, the link is simply left open and the selection is made under program control.

Precision analog reference (optional): parts for the 4.096V precision reference are optional and can be purchased separately from JED as part number AVR200-REFK. Included in the option pack are a MAX874CPA voltage reference IC (U4), 2.2MΩ and 3.3MΩ resistors (R1 & R2), 1MΩ trimpot (VR1), 47nF capacitor (C14) and 4.7μF tantalum capacitor (C15). After installing all of these parts, the output from U4 (pin 6) must be trimmed to precisely 4.096V by adjusting VR1.

Port B – digital inputs (standard): to configure port B for all digital inputs, first install 6-pin socket strips in positions RP5 & RP6. A 4.7kΩ, 5-pin common resistor pack can then be plugged into each of the sockets. As described last month, one end of the socket strip is connected to +5V (pin 6) and the other to ground (pin 1). This means that the resistor packs can be used to perform a pull-up or pull-down function simply by orienting them correctly in the socket strips.

Next, install 4.7kΩ 8-pin series resistor packs in locations RP7 & RP15, and six 4.7V zener diodes in locations Z6-Z9. Make sure that you have the banded (cathode) end of the zeners around the right way. Leave location RP1 empty, as it's only required when using port B for high-current outputs, as described below.

Port B – digital outputs (optional): the upper (PB4-PB7) and/or lower (PB0-PB3) bits of port B can be used as low-current digital outputs, if desired. For example, to use the upper lines as outputs, leave out RP6 and install four low-value series resistors (about 100Ω) in place of RP7. A similar scheme can be applied to the lower lines.

Provision has also been made to use the lower four lines (PB0-PB3) as high-current outputs, if desired. To do this, leave out RP5 & RP15 and install MTD3055VL Mosfets in locations F1-F4. These devices are available separately from JED. A 4.7kΩ, 5-pin common resistor pack must also be installed in the RP1 position.

Naturally, if you decide to expand "upstairs" via J13, then many of these port bits will not be available for general-purpose use on the screw-terminal blocks (J11 & J12). This means that you may be able to leave out some or all of the resistor packs mentioned above.

Port C – TWI (I^2C) port: the lower

two bits (PC0 & PC1) of port C are used for the I²C port. By default, the I²C port is "buffered", so links L24 & L25 (beneath U11) must remain open. Install the 82B715 buffer (U11), the 1.5kΩ and 330Ω pull-up resistors (R3, R4, R9 & R10), and the two 10Ω series resistors (R11 & R12). The two 4.7V zener diodes (Z1 & Z2) that protect the micro's inputs should also be installed.

If you want to connect non-buffered I²C devices, **do not** install U11, R9 & R10 but **do** install the two series resistors (R11 & R12). Note, however, that these must be 100Ω rather than the 10Ω values shown on the diagrams. In addition, links L24 & L25 must be shorted by bridging them with solder.

Port C – digital outputs (standard): in the standard build, the upper six bits (PC2-PC7) of port C drive power Mosfets to provide high-current open-drain outputs. All that needs to be installed here are the Mosfets (F5-F10) and the two 4.7kΩ, 6-pin series resistor packs in locations RP8 & RP9. Locations RP2, RP3, RP13 & RP14 remain empty.

If desired, all of these bits may also function as low-current digital outputs. In this case, omit all the Mosfets and resistor packs mentioned above and install low-value series resistors (about 100Ω) in place of RP13 & RP14.

Port C – digital inputs (optional): to use PC2-PC7 as digital inputs, **do not** install the Mosfets or RP8 & RP9. Instead, install two 5-pin socket strips in locations RP2 & RP3. That done, 4.7kΩ 4-pin common resistor packs can be plugged into these sockets to perform pull-up or pull-down functions, as described earlier.

Next, install six zener diodes (Z10-Z15) in locations RP8 & RP9. These do not appear on the circuit or overlay diagrams, but are simply soldered vertically into the holes left vacant by the two resistor packs. Check that you have the zeners around the right way; the anode ends connect to the ground plane on the topside of the PC board.

Parts List for AVR200 (Standard Build)

1 AVR200 PC board
6 DSS706 EMI suppression filters (LC1, LC4 – LC8)
1 3.6864MHz crystal (HC49U package) (X1)
1 32.768kHz miniature watch crystal (X2)
1 BR1225/1VC 3V lithium cell (BATT1)
2 100µH miniature axial inductor (L1, L2)
1 sub-miniature slide switch (SW1)
1 10-way 2.54mm pitch DIL boxed header (J6)
1 9-way right-angle female 'D' connector (J8)
1 6-way 3.81mm pitch screw-terminal block (J3)
3 5-way 3.81mm pitch screw-terminal block (J2, J11, J12)
4 4-way 3.81mm pitch screw-terminal block (J4, J5, J9, J10)
1 2-way 3.81mm pitch screw-terminal block (J1)
2.54mm pitch SIL header strips (see text)
2.54mm pitch DIL header strips (see text)
2.54mm pitch SIL socket strips (see text)
1 M3 x 6mm screw, nut & washer
1 TO-220 heatsink

Semiconductors
1 DS1233 5V reset IC (U1)
1 ATmega32-16P microcontroller (U2)
1 LM2940T-5.0 low-dropout +5V regulator (U3)
2 TL7726 hex voltage clamping IC (U5, U6)
1 DS1307 real-time clock IC (U7)
1 MAX202E RS232 transceiver IC (U8)
1 P82B715 bi-directional I²C bus buffer IC (U11)
9 MTD3055VL logic-level Mosfets (F5 –F13)
18 4.7V 0.5W zener diodes (Z1-Z18)
1 3mm red LED (LED1)

Capacitors
4 22µF 10V tantalum (C9-C11, C16)
8 100nF 50V monolithic ceramic (C1-C8)
2 27pF ceramic disc (C12,C13)

Resistors (0.4W, 1%)
8 10kΩ (see text)
2 1.5kΩ (R3, R4)
1 1kΩ (R7)
2 330Ω (R9, R10)
2 10Ω (R11, R12)

Resistor packs
3 4.7kΩ 4-pin common resistors (RP2-RP4)
3 4.7kΩ 5-pin common resistors (RP1, RP5 & RP6)
6 4.7kΩ 6-pin series resistors (RP8-RP14, RP16)
2 4.7kΩ 8-pin series resistors (RP7, RP15)

Finally, install 4.7kΩ 6-pin series resistor packs in locations RP13 & RP14.

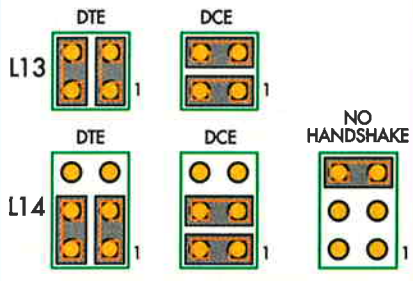
Port D - RS232 (standard): the lower two bits of port D (PD0 & PD1) are reserved for use as the transmit/receive data lines for the serial port. To build the standard RS232 serial interface, install the MAX202 (U8) first, followed by the five 100nF capacitors (C4-C8) if not already in place. Links L20 & L21 should also be shorted by bridging them with solder.

In its most basic configuration, the RS232 port does not provide hardware handshaking; the RTS/CTS lines are

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	8	10kΩ	brown black orange brown	brown black black red brown
❑	2	1.5kΩ	brown green red brown	brown green black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	2	330Ω	orange orange brown brown	orange orange black black brown
❑	2	10Ω	brown black black brown	brown black black gold brown

Setting The RS232 Port Mode



RS-232 CONNECTOR CONFIGURATION LINK SETTINGS

Fig.7: links L13 & L14 are used to set the RS232 port mode. The default configuration is "DCE" with no handshaking, as it allows connection to a PC and use of the MegaLoad software programmer.

simply looped back on the D-9 connector by installing a jumper on L14 (the "no handshake" setting in Fig.7). However, provision has been made for hardware handshaking using port bits PD7 & PD6. This feature is enabled by shorting L22 and installing a jumper on L17 pins 2-3.

As described last month, the RS232 port can be set for either DTE or DCE modes. The required mode is selected via links L13 & L14, as shown in Fig.7.

Port D – three inputs & outputs (standard): of the remaining six bits of port D, three are normally configured as outputs (PD4, PD5 & PD7) and three as digital inputs (PD2, PD3 & PD6).

To use PD4, PD5 & PD7 as high-current outputs, install Mosfets F11-F13 and a 4.7kΩ 6-pin series resistor pack in location RP10. In this case, locations RP4 & RP16 remain empty.

If desired, all of these bits may also function as low-current digital outputs. To do this, simply omit the Mosfets and resistor pack (RP10) and install low-value series resistors (about 100Ω) in the RP16 location.

To configure bits PD2, PD3 & PD6 as inputs, install 4.7kΩ 6-pin series resistor packs in locations RP11 & RP12 and three 4.7V zener diodes in at locations Z3-Z5. Links L15 & L16 allow PD2 & PD3 to be connected to either the screw-terminal block (J9) or the I^2C headers (J6 & J14). In addition, link L18 allows the PD6 input to be pulled up or pulled down.

Note that PD6 & PD7 can be redirected to the RS232 port (via links L17 & L22) in support of hardware handshaking, which would make them unavailable for general-purpose use.

Port D – swapping inputs & outputs (optional): as with all the general-purpose I/O ports described thus far, the standard roles of the six port D bits are easily reversed if more inputs or outputs are needed in a particular application. This is achieved in a similar manner to that already described for ports B & C. However, we've covered it again here to avoid confusion.

To configure bits PD4, PD5 & PD7 as digital inputs, omit the three Mosfets (F11-F13) and install a 4.7kΩ 6-pin series resistor pack in location RP16. Also, leave out RP10 and install three 4.7V zener diodes (Z16-Z18) to protect the micro's inputs. Again, these do not appear on the circuit or overlay diagrams but are simply soldered vertically into the holes left vacant by RP10.

Check that you have the zener diodes around the right way; the anode ends connect to the ground plane on the top side of the PC board.

Next, fit a 5-pin socket strip in location RP4 and plug in a 4.7kΩ 4-pin common resistor pack. The "common" pin of the resistor pack (pin 1) goes to the grounded end (pin 1) of the socket to pull down the three inputs or to the Vcc end (pin 5) to pull them up to +5V.

Finally, to configure bits PD2, PD3 & PD6 as low-current outputs, leave out RP12 and install three low-value series resistors (about 100Ω) in place or RP11.

Port D – RS485 (optional): as mentioned last month, the AVR200 includes support for an RS485/TTL serial port. Parts for this option are available separately from JED (part no. AVR200-RS485K). We do not describe the RS485/TTL serial port here but complete details on installing it will be included on the CDs with the kits and on the JED website.

Note also that "revision 0" of the AVR200 board does not support this option, so be sure to mention your requirements when ordering.

Finally, those with specific cabling requirements will be pleased to know that there are additional rows of pads at the I/O connector mounting positions to allow for machine or crimped-on plug-in connectors. Again, contact JED with your specific requirements.

By now, you should have a fully assembled board, so let's move on and look briefly at what's available for application development. We'll also check out a couple of popular choices for getting your completed code into memory.

Where To Buy A Kit

Kits and options for this project are available from JED Microprocessors Pty Ltd. A complete price list and order form can be downloaded from **www.jedmicro.com.au/avr200.htm**, phone (03) 9762 3588 or email **jed@jedmicro.com.au.**

AVR200 kit $99

AVR200 assembled & tested (standard options) $185

Atmel AVR-ISP $66

Note: all prices include 10% GST.

Software development options

We've already mentioned that Atmel's AVR architecture was designed from efficient execution of compiled code. Development packages that allow you to make the most of this advantage are readily available. Atmel recommend a long list of third-party programming packages in their "AVR 8-Bit RISC Third Party Support" document, available from **www.atmel.com**. Supported languages include C, BASIC, Pascal, Forth and Java.

Apart from the Atmel website, another useful resource for AVR programmers is the very active AVR user's group at **www.avrfreaks.net**. You'll find an even longer list of compilers, assemblers and other goodies in the "Tools" section of their site.

JED Micro use and support several lower-cost development options. Check out their AVR200 page at **www.jedmicro.com.au/avr200.htm** for all the details.

Free assembler & C compiler

For those that need to program AVR micros at the grass roots level, a complete assembler, simulator and debugger is included in the "AVR Studio" software package. The package boasts an integrated development environment (IDE) that allows third-part compliers to be plugged-in as needed.

AVR Studio is free and it's included on the Atmel CD that ships with the AVR200 kit and can be downloaded from **www.atmel.com**.

For the beginner and hobbyist interested in embedded C programming, the free WinAVR GCC compiler offers an excellent, all-round development suite. It has I/O port support, extensive help and embedded support functions for things like delays, EEPROM access, WDT and CRC. It can also produce a debug file for AVR Studio, thus allowing use of the simulation and debugging facilities.

Although WinAVR doesn't include a full IDE like many commercial packages, the "Programmers Notepad" editor can run a "Make" file to automate the whole code generation process. A sample "Make" file is included on the CD with the kit to help first-time users get up and running. WinAVR can be downloaded from **winavr.sourceforge.net** or check out the links on JED's website.

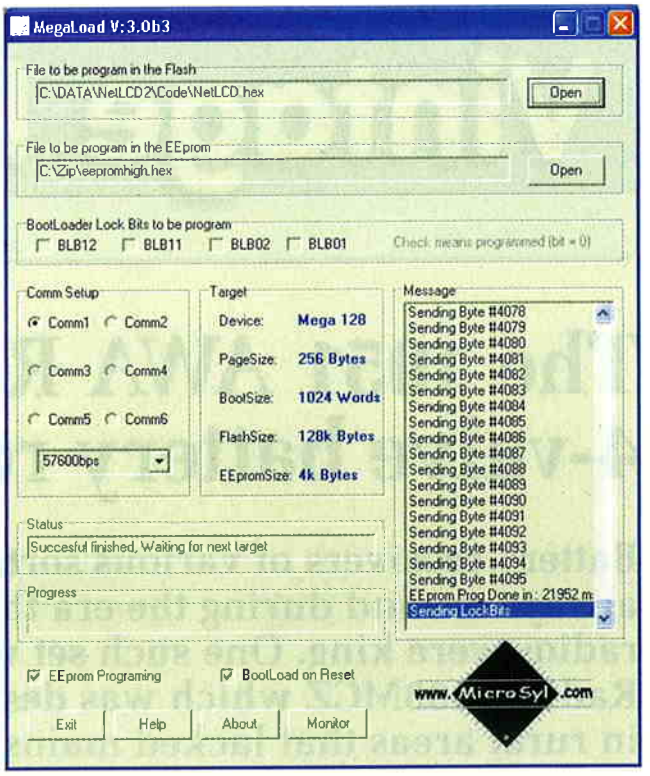


Fig.8: MegaLoad is an easy way to get your code into the ATmega32 and it's free! If you request this option when ordering the AVR200, JED will install the necessary bootloader code into the top of the micro's code memory.

CodeVisionAVR C Compiler

Although at the lower-priced end of the commercial range, CodeVisionAVR from HP Infotech offers ample features and includes a full IDE, including debugger, programmer and terminal. It has library function support for EEPROM access, Dallas 1-Wire, I²C, BCD/Gray code conversion, LCD support, SPI, the Dallas real-time clock and more.

Perhaps one of CodeVisionAVR's best features is the automatic code wizard generator that removes the tedious aspect of setting up your initial register conditions. You can examine all of the other features at **www.hpinfotech.ro** and browse the on-line user group site at **groups.yahoo.com/group/codevisionavr**.

BASIC Compiler

If you need results in a hurry and your C skills are a little rusty, then BASIC compilers are worth a look. MCS Electronics offers a powerful commercial compiler for the AVR series. The package, called "BASCOM-AVR", includes a full IDE, including debugger, programmer, simulator and terminal, as well as comprehensive documentation.

BASCOM-AVR produces fast machine code, not interpreted code like some other products. It includes library support for EEPROM access, Dallas 1-Wire, I²C, LCD, SPI and real-time clock. As a bonus, statements are 99% compatible with Microsoft's QBASIC. View the product details or download a free demo version at **www.mcselec.com**. You'll find an on-line user group at **www.grote.net/bascom**.

Readers interested in purchasing the above products will find links to the appropriate sites from JED's AVR200 page at **www.jedmicro.com.au/avr200.htm**.

Programming the micro

JED is offering two options for getting your programs into the ATmega32 micro. The first of these requires an additional piece of hardware called the AVR-ISP programmer. This device plugs into your PC's serial port as well as the 6-pin section of J13 on the AVR200 board. It accepts the hex or binary file output from your assembler or compiler and programs it into the micro's Flash (program) and/or EPROM (data) memory and sets option fuses all in one operation.

The AVR-ISP is supported by AVR Studio and most third-party development tools. However, for those that don't need to fiddle with the ATmega32's fuses, the "MegaLoad" bootloader and companion Windows application are a much cheaper option.

MegaLoad can be supplied free with your AVR200 kit; all you need to do is tick the right box on your order form. JED will then pre-install it in the top part of the micro's memory (3C00H) before despatch.

To program the micro using MegaLoad, launch the MegaLoad Windows application (supplied on CD) on your PC, connect the AVR200 to the PC serial port and toggle the Reset switch on the AVR200 board. The program code is then transferred over the serial link at 115k bits/second, with no external hardware needed.

Wrap up

JED Micro are supplying two CDs with all AVR200 boards. One includes all AVR200 circuits, layouts, assembly instructions, a test program with instructions and sample code snippets written in BASCOM Basic and CodeVision C. Also included are MegaLoad and a sample setup and Makefile for WinAVR.

The second disk is supplied by Atmel. It contains their complete "Software and Technical Library", including the AVR Studio software suite, product datasheets, application notes, user guides and source code examples, etc.

Now all of that should keep you busy for quite some time! **SC**

Vintage Radio

By RODNEY CHAMPNESS, VK3UG

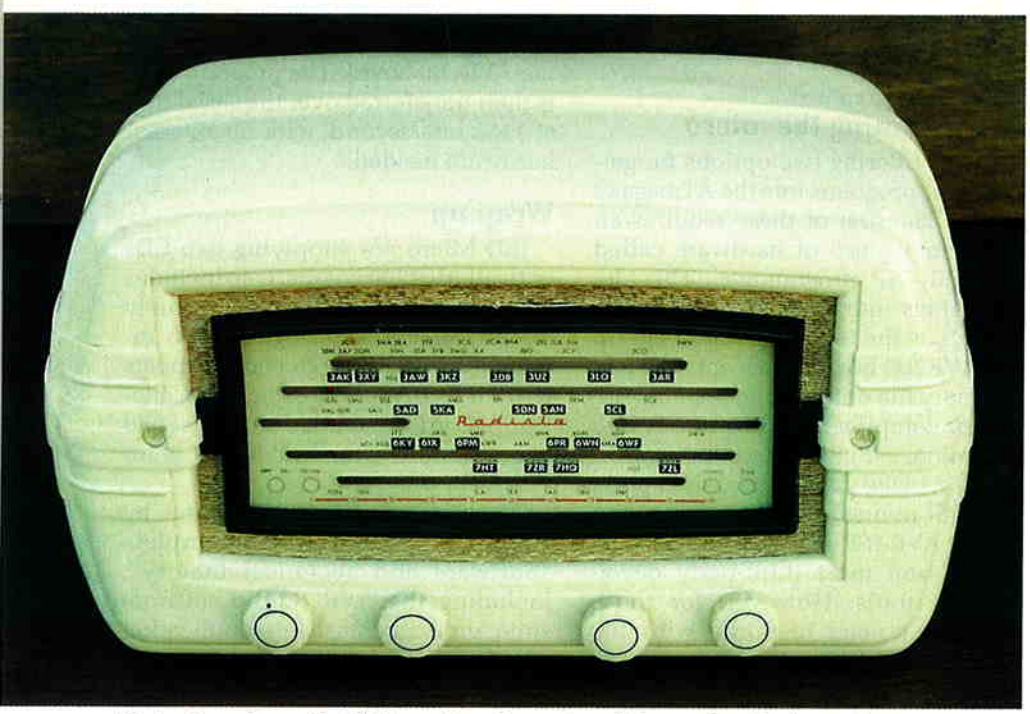
The 1951 AWA Radiola 433MCZ 4-valve battery receiver

Battery receivers of various sorts were always around during the era that valve radios were king. One such set was the AWA Radiola 433MCZ which was designed for use in rural areas that lacked mains power.

Early battery-powered valve sets were based on valves such as the ubiquitous 201, which had a filament requirement of 1A at 5V. By contrast, some of later "battery type" valves required just 25mA at 1.4V to heat them.

In addition, the HT (high-tension) voltage required by the early valves used in battery sets varied from 60V up to about 180V, with valves such as the 1L5G being rated at 180V maximum. In practice though, the 1L5G was usually run with 135V on the plate.

The later "battery-type" valves operated at much lower voltages. They were generally rated at 90V on the plate but were often run at 67.5V.



This view shows the fully-restored receiver. It turned out to be quite a reasonable performer, especially after it had been aligned correctly.

However, there were valves that operated with even less voltage and current on the filaments, such as hearing-aid valves. In fact, the latter typically ran with about 22.5V on the valve plates. It's also worth noting that the space charge tetrodes developed in the 1920s and 1960s ran with plate voltages from around 2V to about 20V.

We didn't see many very low-current valves in Australia and the most common valve line-up in a battery receiver at the end of the valve era was as follows: 1T4 radio frequency (RF) amplifier, 1R5 frequency converter, 1T4 intermediate frequency (IF) amplifier, 1S5 detector and first audio stage and 3V4 audio output stage.

These valves all drew 50mA of filament current at 1.4V, with the exception of the 3V4 which drew either 100mA at 1.4V or 50mA at 2.8V, depending on how the filament was wired. The high voltage (HT) was usually 90V DC.

Design compromises

Achieving low power consumption on both the filament and HT lines meant making compromises in the way these valves operated.

First, because of the low filament drain, the filaments were both mechanically and electrically fragile. In fact, tapping the side of an audio valve with a finger would generally produce an audible "ting" in the output – ie, these valves were noticeably microphonic.

It also meant that they could not tolerate an "over-voltage" condition on the filaments. If the HT was mistakenly connected to the filaments, for example, you could be certain that a

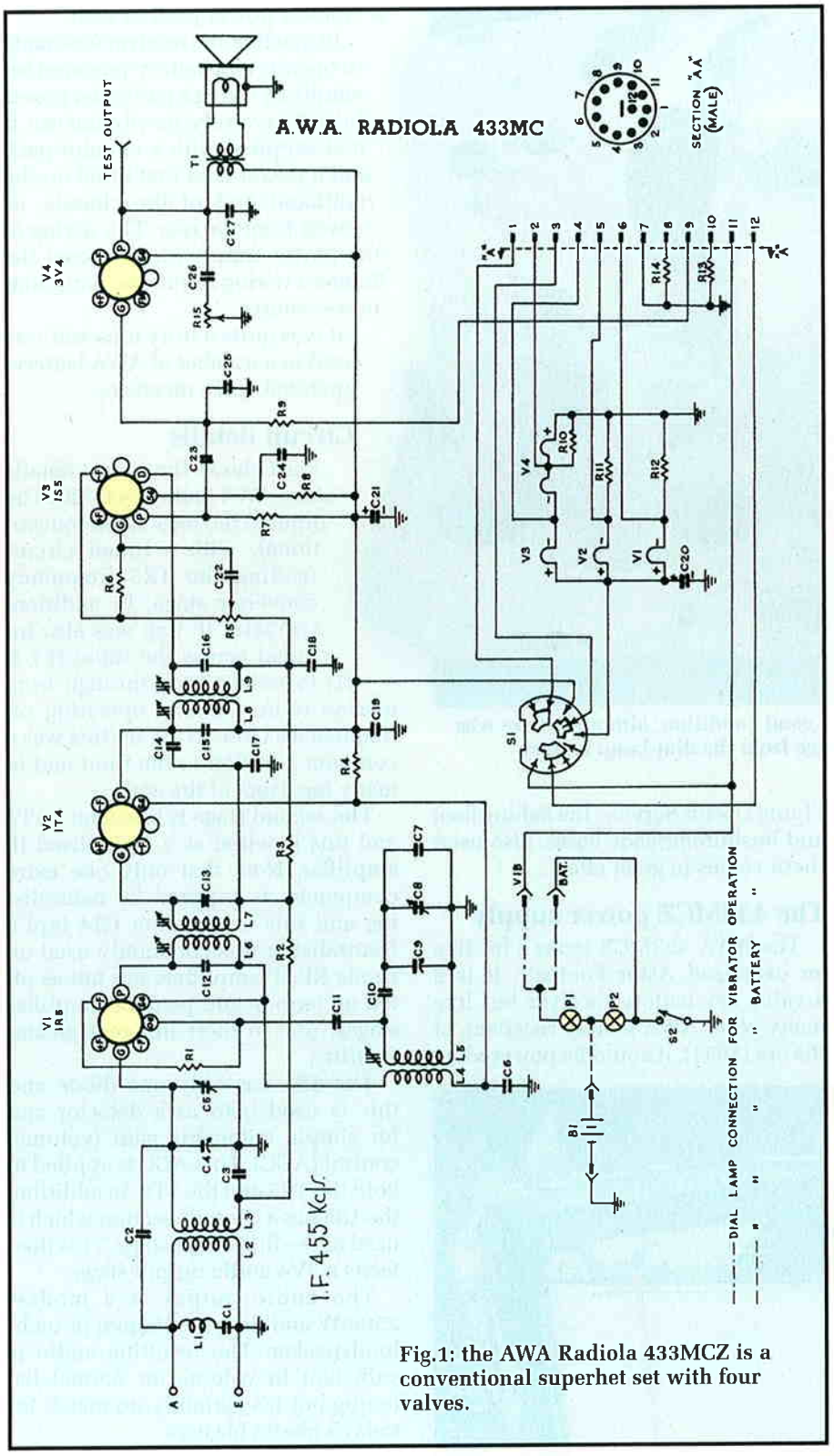


Fig.1: the AWA Radiola 433MCZ is a conventional superhet set with four valves.

new set of valves would be required for the set. Even a 10% over-voltage condition was a recipe for shortened valve life.

Second, the emission life of these valves is limited compared to the more familiar indirectly-heated types. However, the HT voltage wasn't as critical as the low tension (LT) voltage and voltages that were higher than specified could be used with increased biasing (but at the expense of shorter valve life).

It's interesting to note that the HT voltages used by Alf Traeger in his pedal radio transmitters (SILICON CHIP, January 2005) exceeded the valve ratings, with the result that valve life was considerably shorter than normal.

The quest for reduced power consumption also meant that the gain per stage was lower than in a mains-powered receiver during the later years of the valve era. This meant that a 5-valve dry battery receiver (using 1T4, 1R5, 1T4, 1S5 and 3V4 valves) had the same general performance (except for total audio output) as a 5-valve mains-

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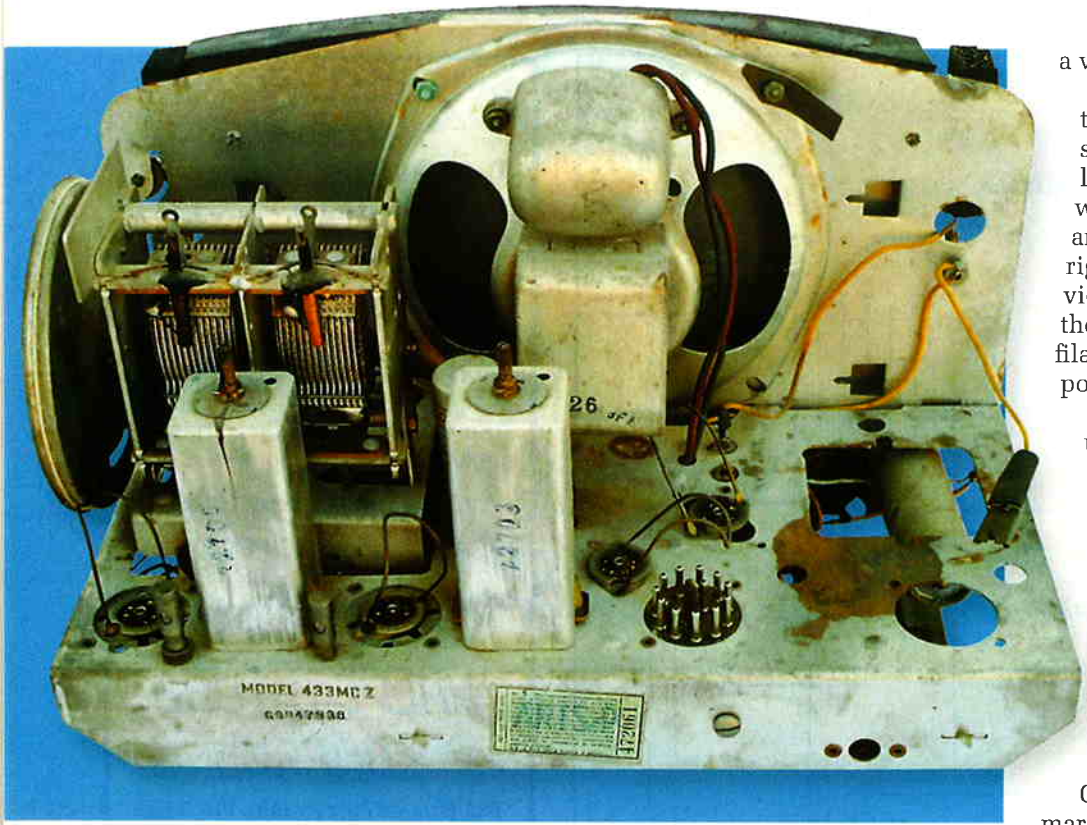


The old Radiola 433MCZ was in relatively good condition, although there was some corrosion on the chassis due to leakage from the dial-lamp battery.

operated set which used one valve as a rectifier.

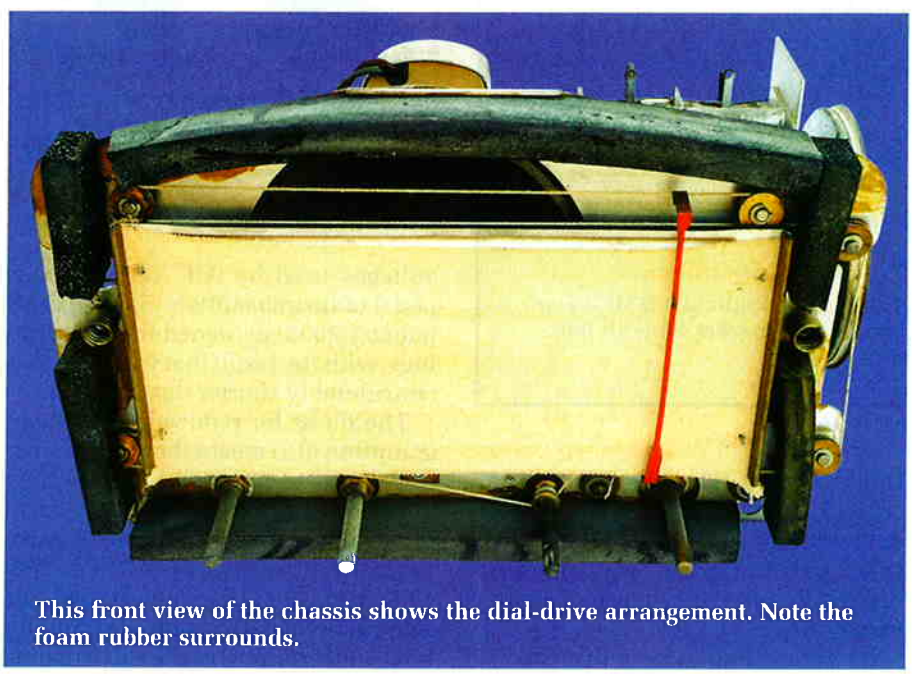
However, the deficiencies of battery-type valves were more than made up for by their economy of operation. This meant they could be used in remote areas, well away from 240V mains and 32V home-lighting plants. Many remote high-frequency (HF) monitoring receivers, as used by the Royal Flying Doctor Service, the fishing fleet and bushfire brigade bases, also used these valves to great effect.

The 433MCZ power supply

The AWA 433MCZ looks a bit like an oversized Astor Football. It is a 4-valve dry battery receiver but like many other AWA battery receivers of the era (1951), it could be powered by a vibrator power pack as well.

In practice, the receiver was made to operate as a battery-powered set simply by fitting a particular power lead. Conversely, for vibrator use, it was supplied with a vibrator pack and a power lead that fitted on the righthand end of the chassis, as viewed from the rear. The wiring of the power supply plugs altered the filament wiring to suit the particular power source.

It was quite a nifty idea and was used in a number of AWA battery-operated valve receivers.



This front view of the chassis shows the dial-drive arrangement. Note the foam rubber surrounds.

Circuit details

Fig.1 shows the circuit details of the AWA Radiola 433MC. The input to the receiver is conventional, with a tuned circuit feeding the 1R5 frequency converter stage. In addition, a 455kHz IF trap was also included across the input (L1 & C1) to reduce breakthrough from marine radio stations operating on frequencies close to the IF (this was a common addition to the front end of many receivers of the era).

The second stage is based on a 1T4 and this is wired as a neutralised IF amplifier. Note that only one extra component is required for neutralising and this is capacitor C14 (4pF). Neutralising was commonly used on triode RF/IF amplifiers but not as often on tetrode and pentode amplifier stages, due to their inherent greater stability.

The 1S5 has only one diode and this is used both as a detector and for simple automatic gain (volume) control (AGC). This AGC is applied to both the 1R5 and the 1T4. In addition, the 1S5 has a pentode section which is used as the first audio stage. This then feeds a 3V4 audio output stage.

The audio output is a modest 250mW and drives a 150mm (6-inch) loudspeaker. The resulting audio is sufficient in volume for normal listening but it's certainly no match for today's ghetto blasters

Cleaning the set

The set itself was quite dusty, having been stored for many years in a relatively dry environment. There was some evidence that a mouse had been in the set but after a short stay, it must have decided that there were better lodgings elsewhere.

The set was generally in quite good condition. However, the 3V battery used for the dial lights had corroded through its case and spilled electrolyte onto the chassis. As might be expected, this caused some rusting and general corrosion of the steel plating in the area affected by the spill (see photo).

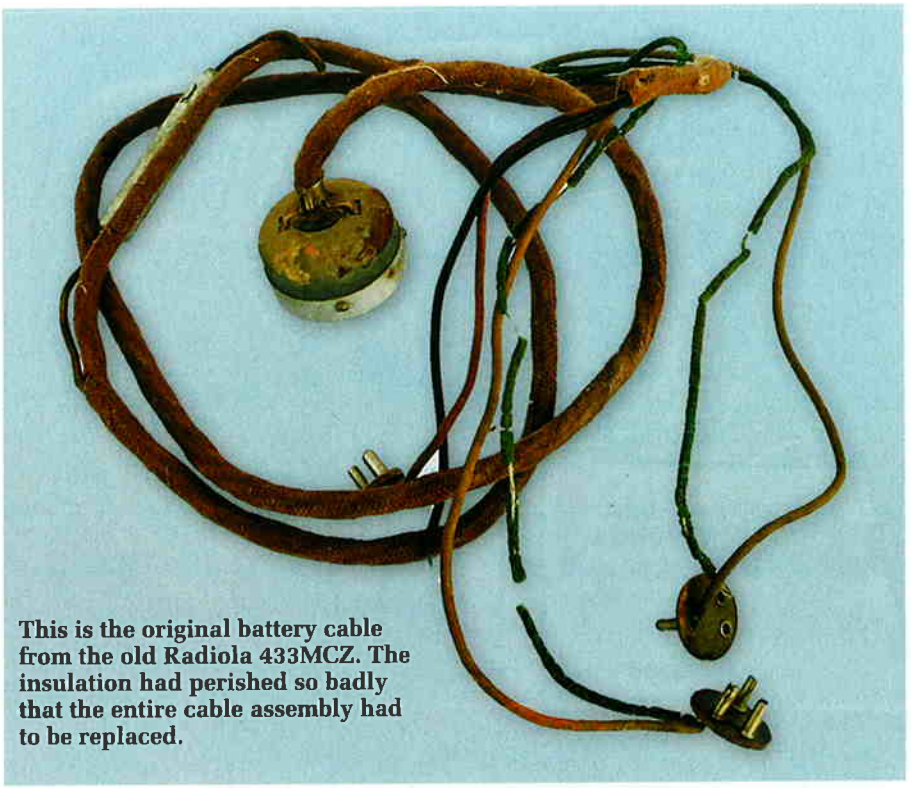
After cleaning up this corrosion, the cabinet and the chassis itself were dusted using a brush and then the valves, cabinet and knobs were washed with soapy water. These parts were then rinsed in clean water and left to dry.

By the way, it's always a good idea to be careful when cleaning valves, to ensure that you don't wash the markings off.

The cabinet was in quite reasonable order, with only one or two cracks in the bakelite. It was given a gentle "going over" with some automotive cut and polish and now looks almost as good as new.

Next, the knobs were given the same treatment and came up well. However, there is a circular groove in each knob that had been painted in the past, along with a dimple on the on-off knob (to indicate on/off position). Only remnants of the original paint remained, so I used an old steel nib pen and some black paint to fill in the grooves and the dimple.

The end result looked terrible until I wiped away the paint that was outside the grooves with a cloth. The edges were then clean and sharp but the knobs were left with a dark grey smudge over them. This was easily fixed – I let the paint dry and then carefully polished the knobs and they came up looking like new.



This is the original battery cable from the old Radiola 433MCZ. The insulation had perished so badly that the entire cable assembly had to be replaced.

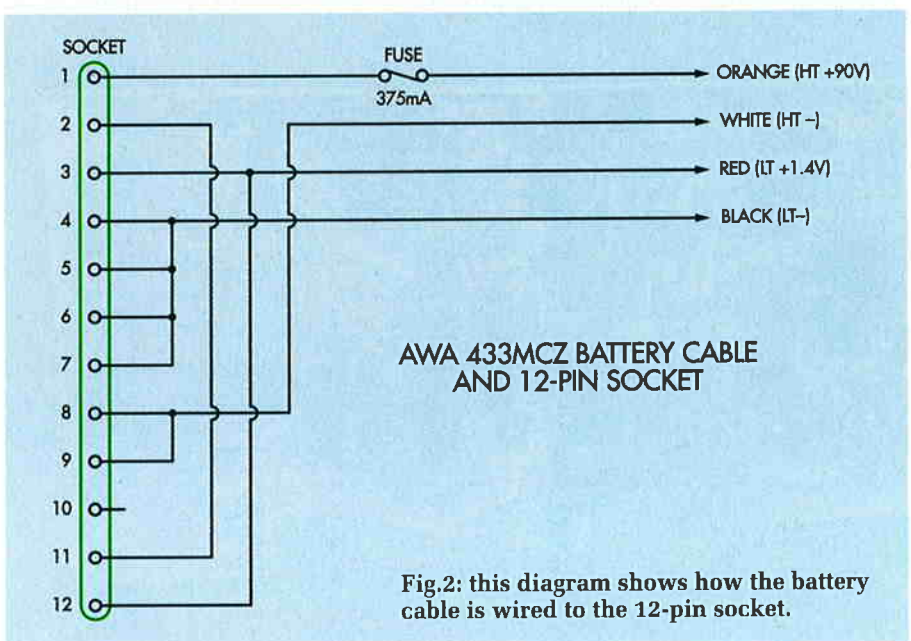


Fig.2: this diagram shows how the battery cable is wired to the 12-pin socket.

Circuit restoration

It was now time for the circuit restoration. First, the rubber insulation on the battery cable leads was in poor condition and so they were replaced with plastic covered leads of the same colour. These leads were then carefully wrapped in insulation tape as far as the cable socket.

The original cable had a 375mA fuse fitted to the HT line but I can see no reason for this and so left it out. If I can work out a way of getting the brown cotton covering off the old cable, I'll slip it over the new cable to make it look more authentic and refit the fuse.

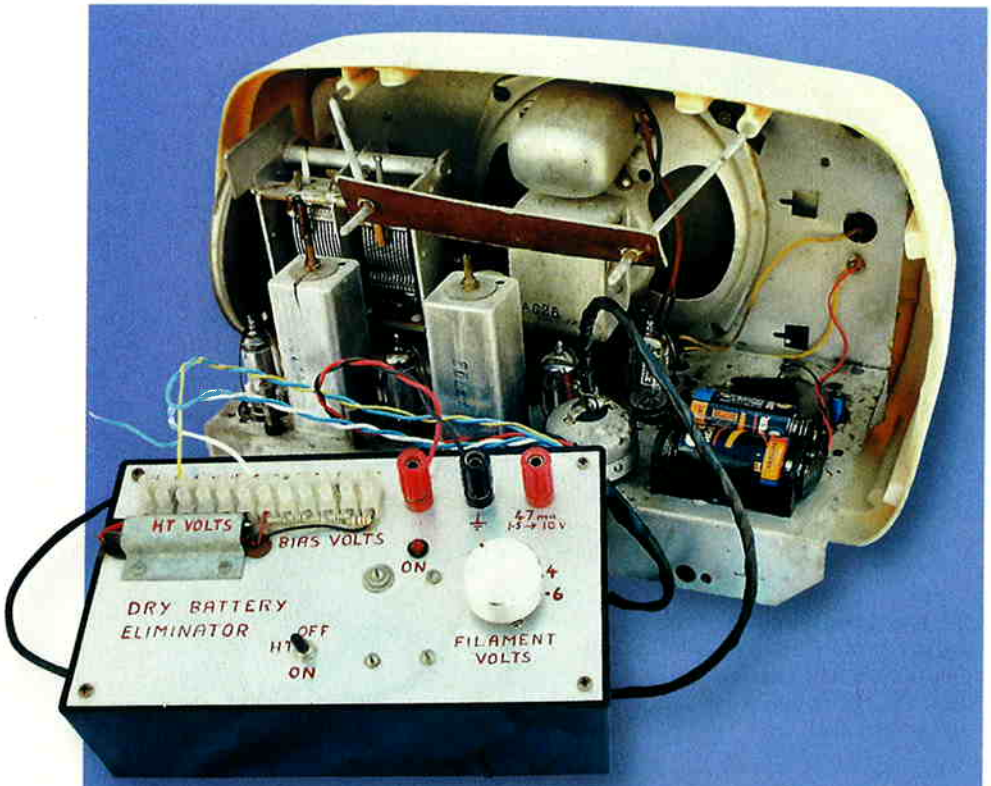
I also left the battery plugs off, as it's more convenient to connect the power leads directly to the power supply. However, you do have to ensure that the filaments are not connected to the 90V line!

My next step was to test all the capacitors and resistors in the set. As usual, a number of the paper capacitors required replacement – ie, the two automatic gain control (AGC) filter capacitors (C3 and C17) and the audio couplers (C22 and C23). The remaining paper capacitors were leaky but were OK to leave in the circuit.

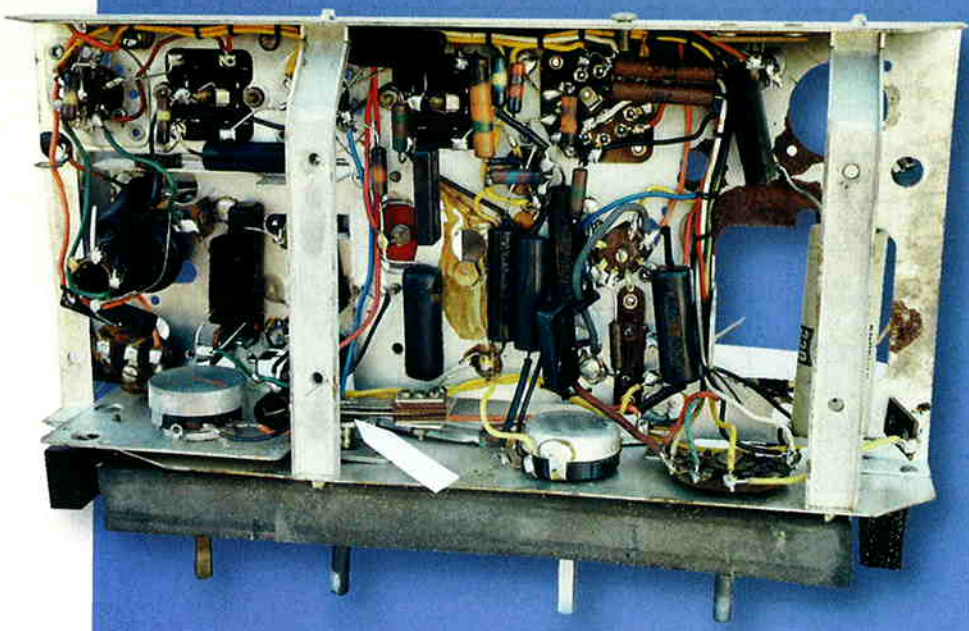
The resistors fared somewhat better and only R14 was well out of tolerance at around 600Ω. It was replaced with a 330Ω 0.25W resistor.

Supply checks

Before installing the valves, I decided to carry out a few simple voltage



Powering battery-operated receivers is no problem if you build a mains-powered dry-battery eliminator.



This is the under-chassis view before restoration. Note the arrow pointing to the dial drive actuated dial-light switch

checks. First, I connected the repaired supply cable to the receiver and did some resistance checks to my "battery eliminator" power supply (which I made about 15 years ago). That done, I switched on and found that the supply voltages (1.4V and 90V) at various points in the receiver were correct.

I then checked the filaments of all the valves using an ohmmeter and all had continuity. The valve sockets were then sprayed with Inox anti-corrosion spray and the valves re-inserted. One of the valves, an N19, didn't match any of the type numbers on the circuit. However, a quick rummage through my valve data books soon revealed that it is equivalent to a 3V4.

The smoke test

It was time for the smoke test so I connected an antenna and earth and switched on. The set immediately showed signs of life and I was able to tune in various local stations.

However, the front end alignment was out and I quickly adjusted the tuning range so that the entire broadcast band could be tuned. I then attacked the alignment of the IF amplifier stage. Three out of the four screwdriver adjustments were nearly spot on but I couldn't get the fourth (L8) to peak at all. The performance improved as I screwed the slug further into the transformer but there was no peak.

I've had this problem before with and the cure has been to replace the IF transformer. Unfortunately, I didn't have a replacement transformer available this time, so I decided to pull the transformer to pieces and replace the mica tuning capacitor (C15).

When I finally removed the capacitor, I checked its value and it read 125pF. However, its correct value is listed in the parts list as 70pF, so I replaced it with a 68pF styroseal capacitor mounted external to the transformer

That done, I adjusted both L8 and L9 in the IF transformer again and the improvement in performance had to be heard to be believed – the set was now performing really well. But why had mica capacitor C15 increased in value to 125pF? Was it incorrectly marked or had it gone high over the years? I really don't know the answer to that question.

The set was now performing quite well but did produce a few "scratching" during tuning, which suggested that the tuning gangs were partially shorting at times. This problem was cured by applying 40V across the plates (with the other components disconnected) and winding the plates in and out a few times. I then switched my high-voltage tester to its 500V range and checked again. There were now no signs of any shorts and the gangs were wired back into circuit.

The dial lamps

The original 3V cycle batteries that were used to power the dial lamps

Photo Gallery: AWA Radiola 55E

Released in 1932, the Radiola 55E was one of the last TRF (tuned radio frequency) consoles manufactured by AWA. It was fitted with an 8-inch (20cm) electrodynamic speaker and used a 4-gang tuning capacitor to tune its three RF stages and detector stage. The valve line-up was as follows: 3 x 235 RF amplifiers, a 224A detector, a 247 audio output stage and a 280 rectifier stage. Photo: Historical Radio Society of Australia, Inc.

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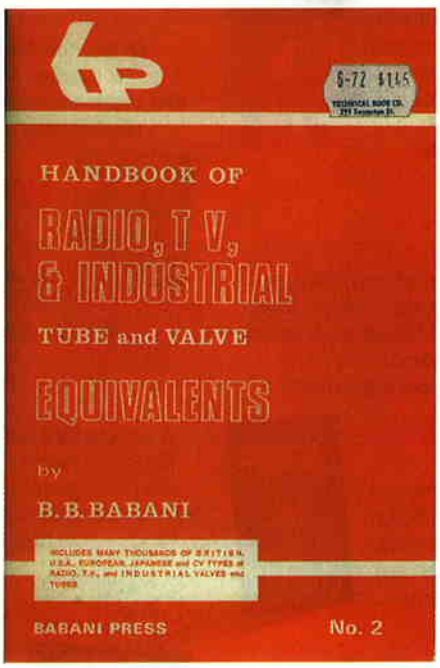
are no longer available, so I fitted a 2 x C-cell battery holder to the chassis and ran the necessary connections to the lamp and to the chassis. At the same time, the old battery lead was kept in place, in case I do happen to come across an old cycle battery down the track.

The original dial lamps had failed and these were replaced with two MES 3.6V torch globes. They are tuned on by pushing the tuning knob and are required at night time because the dial pointer is not particularly easy to see.

Powering battery receivers

Powering a battery receiver is a problem for many collectors, as the batteries are now either unobtainable or very expensive. I first realised this about 15 years ago and decided to do something about it by building the supply shown in one of the photographs. It will handle most battery sets from the mid 1930s onwards, as well as 6V vibrator receivers that draw no more than 1A.

It's important that we collect and restore battery receivers. They are an important part of our radio heritage and this little receiver is well worth having in any collection. **SC**



A good valve equivalents data book is invaluable when it comes to restoring vintage radio receivers.

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Query on loudspeaker resonance

Some time ago, after reading your article on the JV80 speaker system (SILICON CHIP, October 2003), I purchased the speaker kit with the intention of constructing my own boxes. I have finally begun, and for interest I thought I'd check the resonant frequency (Fs) of the drivers. I was most surprised to find that they all measured between 34.5Hz and 35.4Hz. Your article gave it as 31Hz and a search of the internet came up with 29.5Hz.

I am just wondering how sensitive the box design is to such a variation in Fs and would like to know how it was measured for the October 2003 article. (K. W., via email).

● There are a number of significant points about the measurement of speaker resonance. First, the speaker should be mounted on a baffle, typically one-metre square. Second, the speaker needs to be driven from a low impedance source, less than 1Ω. Driving it from a high impedance source will typically raise the measured resonance by a few Hertz. Third, the quoted resonance figure is not an absolute and has a tolerance which could be plus or minus 5 or 10% (what ever the manufacturer specified).

The resonance could also be expected to drop by a few hertz after the speaker has been used for a few hours or more.

Finally, we would not expect the speaker box performance to be affected by a small shift in the resonance.

50W DC load circuit question

This is a question about the 50W DC Load described in the September 2002 issue. Why has a 47µF non-polarised capacitor been specified across the output, as opposed to say, a 47µF polarised electrolytic? Mosfet Q1 has an intrinsic anti-parallel diode, so it can't be just in case the load is accidentally connected in reverse – a regular electrolytic would be protected. (R. Z., Victoria, Canada).

● Good question. We realised that if a low impedance, high current source was connected in reverse across the input terminals, the Mosfet would likely be destroyed, as the fuse wouldn't be fast enough to protect it. Clearly, the lack of robust polarity protection is one of the downsides to such a simple design.

Assuming the Mosfet failed open-circuit, the 47µF capacitor would be the next to go (depending on input voltage). We therefore decided to use a non-polarised electrolytic to limit the damage.

Having said that, you can use a polarised capacitor if you prefer.

FM stereo Micromitter drift problem

I have constructed the FM Stereo Micromitter kit (SILICON CHIP, December 2002). It seems to work fine except that the frequency drifts high after about 10 minutes. All construction appears to be OK. Any suggestions? When it is on frequency, it is quite impressive for such a small unit. (J. T., Winmalee, NSW).

● The phase locked loop must not be operating. Check the lock voltage for around 2.5V, as detailed in the setup procedure. Maybe the coil is not wound exactly as shown, with the same direction and position close to the PC board.

Component-to-RGB Converter Modification

I built your Component Video to RGB Converter (May 2004) and the TV displays pure black. I believe this was mentioned in a later issue of your magazine and it has to do with an "RGB flag" signal to pin 16 of the SCART socket on the TV.

Could you please advise a likely fix? I am using a Jaycar RGB to SCART cable (just the three leads). (M. P., via email).

● The modification to the Component Video to RGB Converter was published in the August 2004 issue, in the Circuit Notebook column on page 77.

Basically the modification is very simple, involving the addition of a mini-pin jack to the rear panel of the Converter between CON6 and CON8. A 220Ω resistor is then fitted to connect the pin jack to the Converter's +5V line (at the right-hand pin of REG1).

A length of flexible hookup wire is then added to your RGB cable, connected to pin 16 of the SCART plug and fitted with a pin jack plug at the Converter end. When the plug is fitted to the pin jack, this connects pin 16 of the TV's SCART input to +5V when ever the Converter is powered up. This seems to solve the problem of a "black screen", with sets such as yours needing an "RGB Flag" signal on pin 16.

Video connection for a hotel TV

Can I make or buy a device that will allow me to view my digital camera output on a hotel TV? That is, a TV with no video input and a secure coax connector for the RF. I thought of an RF modulator but how do I get it to the TV?

Would a dipole antenna cut to length for channel 4 (NTSC) overpower the coax feed? (D. F., Toronto, Canada).

● That's a pretty difficult task. Yes, you can use a modulator but you then need to plug its output into the antenna socket of the TV and then you have to tune the TV set to the modulator's output frequency. The modulator also has to match the system used by the TV (PAL, NTSC, etc). Most countries of the world do not use NTSC.

Notes & Errata

Inductance & Q-Factor Meter, February & March 2005: the specifications incorrectly stated the measurement range of the meter and its power requirements. The correct measurement range is 200nH - 999µH and the maximum current demand is about 300mA.

Also, the orientation of the ISP header on the overlay diagram (Fig.9) and various photos is opposite to that used on the ISP programmer (SILICON CHIP, October 2002). To use a pin-to-pin cable between the ISP programmer and the meter, install the ISP header the opposite way around to that shown on the overlay.

In addition, the 1N4148 diode above IC6 on the overlay diagram (Fig.9) should be labelled D8 instead of D9 and there are several discrepancies in the parts list, as follows: change 9 x 100Ω to 8 x 100Ω resistors; change 1 x 8.2nF to 2 x 8.2nF MKT capacitors; change 6 x 1N4148 to 7 x 1N4148 diodes; and add 1 x 130Ω resistor.

The lack of over-range indication in the original release of the microcontroller code is being looked at by the author and we hope that an update will be available on our website shortly.

Bass Extender, April 2005: under the "Circuit Details" section on page 62, the text in the fifth paragraph states that the circuit shows a sealed enclosure when it actually shows a vented enclosure. The paragraph should be changed to read: "Accordingly, the values of resistors R1, R2 & R3 on the circuit are for vented enclosures. If you have sealed enclosures, R1 should be changed to 27kΩ, R2 to 47kΩ and R3 to 39kΩ".

Clifford the Cricket, December 1994: the 2.2µF electrolytic capacitor is shown reversed on the circuit diagram (Fig.1) but is shown oriented correctly on the parts overlay (Fig.2). Also, the 68kΩ resistor on the parts overlay should be a 10kΩ value, as shown on the circuit diagram and parts list.

Bidirectional Motor Speed Controller, December 2004: the text states that the circuit can operate from a 24V battery. However, due to the gate-source voltage limit of the Mosfets, it is only suitable for use at up to 16V DC (ie, from a 12V battery). However, it should be possible to modify the circuit for 24V operation by fitting 16V zener diodes between the gate and source terminals of each of the Mosfets (Q3-Q6). The accompanying excerpt from the circuit diagram (see Fig.1) shows how to connect the zeners.

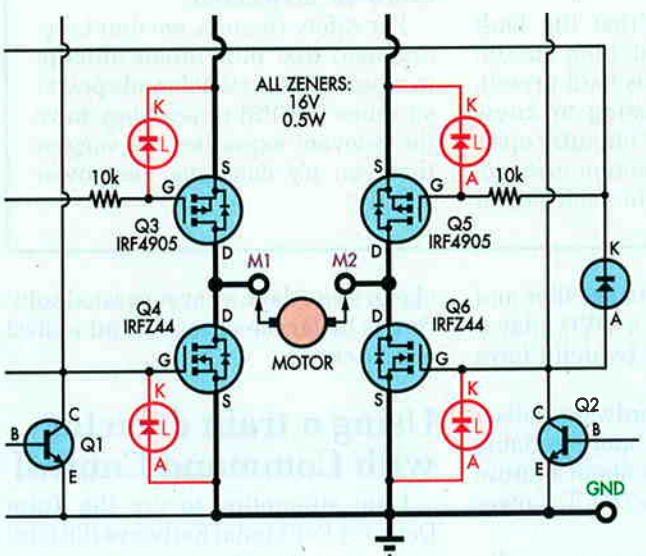

Fig.1: connect 16V zener diodes to the Bidirectional Motor Speed Controller as shown here for 24V operation.

Portable PIC Programmer, September 2003: a few constructors have been unable to adjust VR1 to get the required 5.0V output from REG1, as described in the article. If you encounter this problem, replace the 22kΩ resistor in the collector circuit of Q1 with a 10kΩ value and redo the calibration.

Although we don't recommend the use of the kit to program PIC12C508/9 devices, we've found that it's more likely to program these devices successfully if the 1µF capacitor connected to the cathode of D4 is replaced with a 10µF 35V tantalum unit.

You cannot hope to get your modulator's signal into the shielded coax – you have to make a direct connection to the TV. If the coax cable is secured, you can forget it.

Power boost for Studio 350

I would like to modify the Studio 350 amplifier circuit (January/February 2004) by adding four more output transistors in parallel to increase the wattage. Would there be any problems doing these modifications? (G. M., via email).

● It could be done; two extra transistors per side with ±80V rails would give around 500W into a 4-ohm load. However, there would clearly be some difficulties getting it all connected and working reliably. You might be better off building the 500W amplifier from the August, September and October 1997 issues. It uses a similar circuit, with the same output transistors. The PC boards can be obtained from RCS Radio at **www.rcsradio.com.au**

Comprehensive video source

Having recently successfully constructed both a component video-to-RGB converter and a TV pattern generator (SILICON CHIP designs) has got me thinking. A really useful gadget would be a simple video source, say just colour bars/greyscale but with multiple outputs; eg, composite, S-video, component, RGB, plus perhaps an RF output.

One way to do this is to burn a CD

Heat-Sensitive Computer Power Supply

Recently, my computer has developed a fault which appears to be in the input power supply switching circuit. When I first switch it on (after it has been off for several hours and is "cold"), it shuts down within the first minute or so. There appears to be no power getting to the computer and everything (including the power supply fan) is off.

I then switch it off at the mains, wait for about a minute and switch it back on again. It then switches on as normal.

I am not really familiar with the circuitry for the power supply, but presume that it contains some "protection" circuit which shuts off the supply if there is a fault. If this is the case, I'm not sure if there really is a fault or if the protection circuit is malfunctioning due to a faulty component.

It seems logical that the fault is in the mains switching circuit. Even if I can't fix this fault myself, it would be interesting to know how the "switch on" circuitry operates and what protection arrangements are built in to such power supplies. (B. T., via email).

● We also believe that the problem could be in the power switching circuitry or at least in the power supply itself. Unfortunately, it could also be almost anywhere else in your system, even the motherboard, which controls the power supply via the PS_ON signal. Here's one possible scenario that may help explain what we mean:

If the heatsink on the microprocessor were to come adrift, it would rapidly overheat at power up. Some motherboards have the capability to shut down the power supply when the processor temperature exceeds a certain value – possibly just minutes after power up!

If you're curious about your supply, you'll find the schematic of a typical unit at: **www.pavouk.comp.cz/hw/en_atxps.html**.

For safety reasons, we don't recommend that individuals attempt to repair off-line switchmode power supplies (SMPS) unless they have the relevant expertise. We suggest that you try changing the power supply!

with appropriate jpeg image files and access these through a DVD player with multiple outputs (which I have already done).

However, a simple hardware realisation could be cheaper, more portable and more reliable. How about a future project along these lines? (H. T., Lower Hutt, NZ).

● Given that DVD players are really cheap these days, your suggested solution is by far the cheapest and easiest approach.

Using a train detector with Command Control

I am attempting to use the Train Detector For Model Railways (SILICON CHIP, June 1995) with a Command Control System, without success. Can the Train Detector system be made to work with these Command Control systems. (R. S., Bundaberg, Qld).

● Unless you have your layout divided up into blocks, which is probably unlikely if you are using a Command Control system, then the Train Detector is not practical. Having said that, you should still be able to get it to work although note that the 4mH isolation choke L1 (shown on Fig.4, page 29) should be inserted in series with the output from your Command Controller to the rails.

Windows-based EPROM programmer

I have built the EPROM Programmer and not being a programmer myself, I need to be able to program (for a pinball machine) 2716 EPROMs (24-pin, 2048 byte), which is priority 1. Also 2316 masked ROMs (or not) and 2732 EPROMs are priority 2.

The programs themselves are available but for the 2716 I need to know how to adapt them or is the 24-pin adapter suitable? (A. M., via email).

● The answers to your questions are as follows:

(1). The programmer cannot program 2716 EPROMs. This is because it was designed for devices that use 12.75V or 21V programming voltages, whereas the 2716 requires 25V.

(2). The programmer can handle 2732A EPROMs using the 24-pin adapter described in the instructions.

(3). 2316 PROMs are factory (mask) programmed and cannot be erased or reprogrammed. However, some pinball machines will accept 2716 or even 2732 EPROMS instead with a jumper/link change. **SC**

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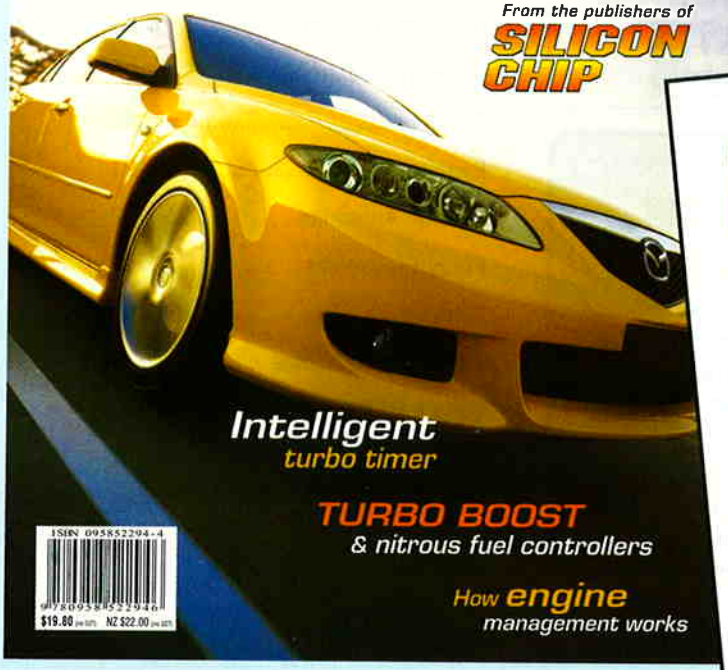

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